Water Reclamation Facility
Biosolids Market Analysis

Fall 2016 • Management 641 Industrial Ecology

Class Reports Compilation • Management 641 • Industrial Ecology

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SCYP
Sustainable City Year Program

University of Oregon

SCI

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About SCI

The Sustainable Cities Initiative (SCI) is a cross-disciplinary organization at the University of Oregon that promotes education, service, public outreach, and research on the design and development of sustainable cities. We are redefining higher education for the public good and catalyzing community change toward sustainability. Our work addresses sustainability at multiple scales and emerges from the conviction that creating the sustainable city cannot happen within any single discipline. SCI is grounded in cross-disciplinary engagement as the key strategy for improving community sustainability. Our work connects student energy, faculty experience, and community needs to produce innovative, tangible solutions for the creation of a sustainable society.

About SCYP

The Sustainable City Year Program (SCYP) is a year-long partnership between SCI and one city in Oregon, in which students and faculty in courses from across the university collaborate with the partner city on sustainability and livability projects. SCYP faculty and students work in collaboration with staff from the partner city through a variety of studio projects and service-learning courses to provide students with real-world projects to investigate. Students bring energy, enthusiasm, and innovative approaches to difficult, persistent problems. SCYP's primary value derives from collaborations resulting in on-the-ground impact and expanded conversations for a community ready to transition to a more sustainable and livable future.

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About Albany, Oregon

The city now known as Albany has an established history as a central hub in the Willamette valley. Founded in 1848 and incorporated in 1864 the city has served as the Linn County seat since 1851. Albany's unique place in Oregon's history is exemplified in its dedication to historical preservation. Albany is often noted to have the most varied collection of historic buildings in Oregon. Its "four historic districts are listed in the National Register of Historic Places by the United States Department of the Interior." This downtown core has served as the center of revitalization efforts since 2001.

Located on the Willamette and Calapooia rivers Albany spans both Linn and Benton counties. With a population of 51,720 people, Albany is Oregon's 11th largest city and the second largest city in Benton County. Albany is administered under a home rule charter, adopted in 1957 establishing a Council and City Manager model. The city's vision, to be a "vital and diverse community that promotes a high quality of life, great neighborhoods, balanced economic growth and quality public services," is exemplified by its administration and government. Albany has a very active civic community with nearly 100 citizens serving on advisory commissions and committees dedicated to municipal issues.

Historically, Albany's economy has relied on natural resources. As the self-styled "rare metals capital of the world," Albany produces zirconium, hafnium and titanium. Major employment sectors include "wood products, food processing, and manufactured homes." Because of its short, dry temperate growing season Albany farmers excel in producing specialized crops like grass flower and vegetable seeds, "tree fruits, nursery stock, nuts, berries, mint and grains." Albany and the surrounding (Linn and Benton) counties are so agriculturally productive it is often called "The Grass Seed Capital of the World."

Albany's central location and mild climate has made it a popular destination for a variety of outdoor and leisure activities. Located in the heart of Oregon's most populous region with the Pacific coast to the west and the Cascade range to its east, Albany is connected to the wider state by Interstate 5, Oregon Routes 99E and 34, and US Route 20. The city is also served by Amtrak, a municipal airport, and a local and regional bus network.

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Executive Summary

The University of Oregon Master of Business Administration and Master of Accounting students collaborated in Joshua Skov's graduate-level course in Industrial Ecology (MGMT 641), investigating the possibilities for the marketing and sale of outputs from the treatment of wastewater (sewage) at the Albany Water Reclamation Facility. In the city's previous wastewater treatment facility, sludge was processed into Class B Biosolids and given to grass seed farmers in the area. In the city's current wastewater treatment facility, the city conducted a composting pilot project. The goal of this project was to identify markets for the composted biosolids as well as potential local partners, and make recommendations for the structure and details of potential projects. In addition to considering the existing grass seed market, the class researched the potential markets by conducting surveys of farmers around Albany, Oregon. The farms include hops, pears, dryland wheat, blueberries, and christmas trees. Students selected these markets based on the environmental benefits of biosolids to agriculture, forestry, and land reclamation.

Students researched best practices from around the country and summarized successful implementations. They selected and researched treatment facilities with similar locations, community size served, an existence of public-private partnerships, and/or classification of biosolids and their subsequent applications. They then explored the types of potential bulking material. The addition of bulking material is a critical component to the composting process for creating higher class biosolids. Students examined bulking materials in use across a wide range of biosolids and other organic waste composting processes. Research revealed three primary types of compost operations: Aerated Windrows, In Vessel, and Anaerobic Biodigestion.

Lastly, the class assessed the possibility of a public-private partnership. Students met with several private corporations that partner with public institutions to create value for all stakeholders in a solid waste management system. The research revealed the chemical and environmental value of biosolids, but that given public perception, biosolid-derived fertilizer cannot compete against plentiful, cheap synthetic fertilizers derived from natural gas. The class suggests a series of considerations for Albany. They also suggest immediate exploration of a partnership deal under a Design-Build-Operate (DBO) model. The City of Albany can seek reduced cost funding under the Clean Water State Revolving Fund (CWSRF).

Biosolids Background

Sources of Biosolids

The raw material that is processed into biosolids comes from the removal of solid wastes from wastewater in a municipal treatment plant. This sewage sludge requires processing to remove harmful contaminants and microorganisms, with the concentrations of pathogens and toxic chemicals below regulation-specified level. The end biosolids product is high in nitrogen and carbon compounds as well as beneficial microorganisms. The form, water content, usability, and regulatory requirements differ depending on the type of processing. The sewage sludge can be digested anaerobically, which generates high-methane biogas rather than agricultural biosolids. The sludge can also be digested aerobically, in which air is pumped or bubbled. This process yields significant carbon dioxide. The digested solids are then dewatered to achieve a solds content of 15-25% for disposal, land application, or further treatment for reuse. Composting is a popular further treatment process, in which the dewatered sludge is mixed with a bulking material like sawdust or wood chips and composted aerobically. Composting typically happens outside in static rows or piles. The end goal is a fairly uniform product with low water content and a high carbon to nitrogen ratio. Another more expensive process for further treating dewatered biosolids is thermal drying, in which the sludge is dried and concentrated to create low-water content pellets that can be used for agriculture or burned as a fuel.

Uses

Biosolids are typically used to replace synthetic and other fertilizers in agriculture, landscaping, forestry, and gardening. Biosolids have many benefits over synthetic fertilizers, including: Increased crop yields and other plant growth, enhanced soil quality and fertility, increased water retention capacity versus sandy soils and improved drainage in heavy soils, reduced erosion, higher biodiversity in soil microorganisms, and improved habitat for small animals. Biosolids are also used in land reclamation to replace damaged or nonexistent topsoil, and to rehabilitate environmentally compromised land.

Classes and Regulations

Biosolids are regulated in the United States by the Environmental Protection Agency (EPA) Part 503, as well as state-level laws. These rules apply whenever biosolids are applied to land. Class A Biosolids have virtually non-detectable pathogen levels, odor, and vector attraction (flies, mosquitoes, etc.). Class

A Biosolid material may be achieved with further sludge treatment options such as, lime stabilization, composting, thermal drying, or soil amendments. These materials can be applied to land as fertilizer or soil amendments. Local restrictions govern how long a landowner must keep humans and/or animals away from contact with biosolids, typically 30 days to one year (for vegetables grown in contact with biosolids). Class A, EQ, or AA exceed the pathogen and vector attraction standards for Class A.

Class B Biosolids have detectable pathogen levels. There are likely permits required for application of Class B with provisions for harvesting and public access. Local restrictions may be stricter than the EPA.

Public Perception

There has been historical controversy regarding the application of biosolids, due to perception about the odor, pathogen content, and original source of the material. This has led to more Class A and AA Biosolids use compared with B, but some companies that process organic wastes (see the Public-Private Partnership Report) feel that consumers may object to using biosolids on their own property. Additionally, farmers that grow organic foods cannot apply biosolids, as FDA Organic standards do not permit sewage sludge-derived fertilizers.

Report Summaries

Existing and Historical Markets: Grass Seed Farming

Survey of local farmers concerning their past use of biosolids under the Albany pilot program and openness to purchasing biosolids

In 2009, the City of Albany halted its production of Class B Biosolids as it transitioned to a new solid waste treatment facility. The majority of the biosolids produced by the city prior to shutting down the plant were given away to grass seed farmers at no cost in addition to providing the transportation and application service for the farmers. Today, the city is looking towards reviving its biosolids program. The primary concern for the City of Albany at the moment is whether or not it will be able to procure similar agreements when the new biosolids program is fully operational.

Most grass seed farmers are family businesses, in other words, sole proprietorship. Research has shown that sole proprietorships are slower to adopt new technologies, which exacerbates the traditional problems of changing behavior for farmers. Additionally, the education process, regulation of use, and the cost to farmers are the biggest concerns.

The type of biosolid that would be most useful to grass seed farmers is Class B. Grass seed farmers have unique sets of requirements. Since the crop is not for human consumption, the treatment requirements are lower and there are fewer application restrictions. One critical insight is that biosolids require different upkeep and knowledge than traditional fertilizers.

We recommend three approaches:

- The city can provide a subsidy to the grass seed farmers that receive the solids, which allows farmers to become more familiar with a new way of fertilizing their fields.
- The city can share the cost with farmers. Farmers might pay for the transportation and application while city continues pay for the infrastructure and supply the nutrient value for biosolids free of charge.
- The city can ask biosolids consumers (especially those requiring a more refined product) to help pay for the infrastructure improvements required to deliver such outputs.

Potential Biosolids Markets: Evaluation of local crops for suitability to biosolids fertilizer application

We researched a variety of farms near the City of Albany and surrounding areas in Oregon, the majority of which produced food. We contacted these farmers to learn more about their use of biosolids. We conducted surveys on the following types of farms:

- Hops
- Pear
- Dryland wheat
- Blueberries
- Christmas trees

There are health and safety concerns that could make it more difficult for farmers to switch to biosolids. According to the pear farmer, they lost 20 cows from biosolids-fed orchard hay, it is believed to be most likely due to contamination from the biosolids. The blueberry industry is not an ideal market for biosolids because they are usually picked by the public who cannot be in contact with biosolids due to safety concerns. Christmas trees are not food so the regulations on using biosolids are less strict. However, only one Christmas tree farm was interested in more information. Studies have shown that biosolids have the potential to increase the value of Christmas trees because organic nutrients improve a Christmas tree's height and look. This has also been seen in forestland reclamation projects.

Challenges for farmers varied from food regulations to lack of education about biosolids. We recommend that the City of Albany consider partnerships with associations, pilot projects, and a joint education campaign around biosolids benefits and uses to further explore the markets and their potential. Based on our research the Christmas tree market has the most potential because of the number of growers in Oregon and fewer regulations. Biosolids can also offer a clear benefit for growers producing greener, larger trees, which can lead to higher sale prices.

Environmental Benefits of Biosolids Application: Literature review of the quantifiable benefits of biosolids to crop yields, biodiversity, water flow, and other environmental metrics

Implementing a biosolid treatment program has environmental benefits and financial benefits. The waste would be diverted from the landfill and repurposed as natural fertilizer. Biosolids can be processed into a convenient fertilizer and soil-builder for crops, a tool to restore exhausted land, and as a vehicle for reducing greenhouse gases in the atmosphere. There are some risks inherent with the use of biosolids including trace metals, pathogens, and excess nitrogen found in the soil. The intent of this section is to inform policymakers and waste treatment personnel on the environmental benefits of increased integration of biosolids into the residential, commercial, and industrial ecosystem of Albany. "Ecosystem services" can be broadly defined in terms of their contribution to air quality, water quality, and land value. By increasing soil health, ecosystem services effectiveness is increased for a variety of land-based economic activities.

The ecosystem services that result from application of biosolids fertilizer are:

- Increased yields through more efficient nutrient cycling
- Increased yields through increased soil biodiversity
- Reduced emissions due to reduced support of chemical fertilizer industries
- Increased drought resilience through increased soil moisture
- Decreased wind erosion through increased soil moisture and diverse soil composition
- Social benefits due to local project management of biosolids integration

Effective applications of biosolids to forest lands and timber resources can enhance the quality of these ecosystem services through:

- Increased yields through more efficient nutrient cycling
- Increased yields through diverse soil composition
- Increased biodiversity due to habitat formation

Land reclamation projects have a longer life cycle, therefore the environmental benefits are magnified:

- Increased air quality due to long-term carbon storage
- Increased air quality due to decreased transportation emissions
- Increases in biodiversity due to greater vegetative growth
- Increased water quality due to wetlands restoration

Biosolids fertilization provides economic value to rural communities by complementing industries that drive rural economies—agricultural production, commercial and conservation forestry, and resource extraction. When applied correctly, biosolids benefit soil health, increase yield gains, increase water and air quality, and increase biodiversity due to habitat formation.

Best Practices for Biosolids Programs: Review of municipal biosolids processing and marketing programs across similar communities to Albany

We have evaluated current wastewater treatment facilities involved in the production of Class A and B Biosolids to provide the City of Albany with a broad range of successful operations from which they may find attributes they wish to integrate into their new facility. We selected and researched treatment facilities in similar locations, size of community served, existence of public-private partnerships, and/or classification of biosolids and their subsequent applications. The cities and counties analyzed include: City of Everett, City of Centralia, King County, and Spokane County in Washington; Orange County and Solano County in California; Lee County in Florida; and Lancaster Area Sewer Authority in Pennsylvania.

Analysis of Bulking Materials for Biosolids Composting: Comparison of compost bulking materials across a wide range of critical criteria

The addition of bulking material is a critical component to the composting process for creating higher class biosolids. Significant research was performed on the bulking materials used to produce different types of biosolids and other organic waste composting processes. The choice of bulking material depends on the volume of biosolids being processed, the geographical area where the composting facilities are located, the desired moisture level in the input and output products, supply volume and consistency, and the type of processing operation. Research revealed three primary types of compost operations:

- Aerated Windrows: Organic material combined with bulking materials and exposed to airflow in long narrow piles.
- In Vessel: Organic material is combined with bulking materials in an enclosed environment to facilitate control of mixing and oxygenation levels.
- Anaerobic Biodigestion: Organic waste material sealed in an anoxic environment to be broken down by microorganisms into biogas and methane.

Given the location of Albany in a timber-producing region, wood waste was the primary target of investigation. Wood waste from timber mills is consumed by three primary markets: Paper mills using pulp and bark waste, engineered wood production producing plywood, particleboard, and wood pellets, and cogeneration plants in Japan and China burning wood chips for power. The research considers alternative bulking materials like yard trimmings, food byproducts, industrial organic byproducts, and municipal solid waste. The availability and chemical composition of each bulking material are the significant deciding factors.

The recommendation, considering chemical, physical, financial, and volume concerns, is to pursue wood waste as a bulking materials. The supply of wood chips and dust is available as long as the demand is consistent.

Public-Private Partnership Models for Biosolids Management: Discussion with biosolids processing businesses and comparison of partnership models with implications for Albany

The research team met with several private corporations currently partnering with public institutions and creating value for their stakeholders in solid waste management systems. Four different potential biosolid output products were considered: Class B Dewatered, Class A Lime-stabilized, Class A Compost, and Class A Thermally Dried Pellets. Class B and Class A Lime-stabilized products were found to have significant drawbacks due to their proneness for odor and stricter regulatory requirements. Class A Compost is recognized to have significant benefits in landscaping and horticulture, but suffers from consumer stigmatization due to its origin. Nonetheless, several communities have active Class A Compost creation partnerships. Class A Pellets were found to offer the most attractive product, with markets including agriculture, golf courses, and turf areas in athletic fields and parks.

The research revealed the chemical and environmental value of biosolids, but that given public perception, biosolid-derived fertilizer cannot compete against plentiful, cheap synthetic fertilizers derived from natural gas. To create a marketable biosolids product, any partnership must consider:

- Scale and Proximity: Many successful partnerships have aggregated solid wastes from a wide swath of municipalities to spread the fixed costs and increase output.
- Regulation: Potential private partners specialize in compliance and offer indemnification for the city.
- Expertise: Municipalities are not accustomed to developing and marketing products. Businesses bring in marketing experience and educational challenge of selling biosolids as well as the technical details of the processing facilities.
- Capital and Resources: Private entities may have more ready access to capital outside of the legislative process. The business can create a partnership structure that leaves the municipality revenue-neutral, eliminating the current waste disposal fees.
- Contracts: Due to the high cost of the fixed facility assets, private entities will desire longer-term contracts, which may be difficult for municipalities. Some businesses are offering more favorable terms of five to ten years, with variable payments based on biosolids success and prevailing economic factors.

The research team recommends the immediate exploration of a partnership deal under a Design-Build-Operate (DBO) model. Albany can seek reduced cost funding under the Clean Water State Revolving Fund (CWSRF) program. The facility will be owned by the city, and leased to the private partner under a possessory lease.

Existing and Historical Markets: Grass Seed

Jacob Lubman, Micah Canal, Michael Park

Introduction

In 2009, the City of Albany halted its production of Class B Biosolids as it transitioned to a new solid waste treatment facility. The majority of the biosolids produced by the city, prior to the program's termination, were given to grass seed farmers at no cost. The city also provided transportation and application services for farmers. Today, the city is looking towards reviving its biosolids program. The City of Albany is interested in learning if it will be able to procure similar (or more favorable) agreements if the new biosolids program is fully operational. During Albany's biosolid program, grass farmers utilized the majority of the biosolids. This section analyzes if current grass seed farmers may also be interested in a new biosolid market.

Objectives

- Determine the feasibility of recreating or initiating partnerships with grass seed farmers in the vicinity of Albany.
- Gauge interest in biosolid use for grass seed farmers currently using other fertilization methods.
- Provide a cost analysis of potential outcomes for Albany.
- Determine the most practical type of biosolids for grass seed farmers.
- Research trends and best practices in the biosolids and grass seed industries.
- Identify the balance of power in the relationship between municipalities and farmers.

Methodology

Chris Bailey, City of Albany Public Works Director, provided historical context of the biosolids program and helped create a scope for student research. Chris also answered follow-up questions and helped refine the grass seed farmer questionnaire (Appendix A).

From November 4 to 28, 2016, students called grass seed farmers. In total, students called 32 farmers and wholesalers, with at least two attempts per contact. Students interviewed one party, a wholesaler who preferred to remain anonymous.

Questionnaire development

Our questionnaire focuses on the needs of grass seed farmers. It asks questions about preferred biosolid type (A or B), form (cake, pellet, compost, and liquid), and total demand by acre. Questions attempted to understand negative perceptions of existing fertilization methods to recommend a marketing strategy for Albany's biosolids program. The questionnaire subtly probed farmers for willingness to pay for biosolids. It was projected that Albany farmers would be unwilling to pay reasonable market prices because they previously received biosolids free of charge, with transportation and application services. This was projected because farmers satisfied with the previous arrangement mentioned the free provision as a major component of their satisfaction.

Discovery

Grass seed farmers exhibit many of the same regressive tendencies as traditional farmers. Biosolids are new and stigmatized, and a significant body of research has shown that farmers are slow adopters of new technologies. They require highly targeted educational materials and programs to become adopters. This industry also has a small digital presence. Albany might coordinate an outreach effort to reach grass seed farmers about the potential benefits of farming with biosolids.

Grass seed farming, like agriculture, is primarily a family business. The majority of grass seed farmers active in Albany are second or third generation, and are overwhelmingly sole proprietorships. This type of industry makeup lends itself towards an evangelist strategy, as an inside perspective will carry much more weight than many other types of outreach. Research has shown that sole proprietorships are slower to adopt new technologies, which exacerbates the traditional problems of changing farmer behavior.

Traditionally, municipal waste has been treated as the responsibility of the municipality. The vast majority of municipalities producing biosolids do so only to avoid sending waste to landfills. While industrial ecology best practices suggests viewing all outputs as inputs for other systems, the market does not currently treat biosolids this way. While biosolids have a strong nutrient profile and can make excellent fertilizer for certain crops, there are a number of limiting factors in the current market for biosolids:

- The main selling point for biosolids is how rich they are in nitrogen, but acquiring ample nitrogen is currently incredibly cheap, driving down the desirability of biosolids.
- Biosolids will always require more education and marketing due to the stigma of being human waste.
- Biosolids are produced at a relatively low volume (particularly in a city the size of Albany) and are unable to serve needs of a large segment of the market. While this low volume makes it easier to offload all of the material, it makes it difficult to popularize.
- Extensive regulation is required for biosolids, which can be confusing for farmers.

Class B Biosolids are most useful to grass seed farmers. Grass seed farmers have a unique set of requirements. Since the crop is not for human consumption, the treatment requirements are lower and there are fewer application restrictions than on other crop types. Grass seed farms have unusually high acreage, meaning they require more total volume of fertilizer. Since Class B Biosolids are almost ten times more voluminous than more treated classes, Class B would be a better fit for grass seed farms. Research found no previous cases of grass seed farmers using other classes of biosolid.

Biosolids require different upkeep and knowledge than traditional fertilizers. Understanding of fertilizer application is not transitive to other fertilizer types, and biosolids require the most of any fertilizer type. Mixed application types create unnecessary complexity and significant monitoring of fields. Typically, farmers that use biosolids do not use other forms of fertilizer to better regulate their unique profile. The size of grass seed operations in Albany suggest there lacks a farm small enough to convert completely to a biosolid fertilizer. Biosolid application also requires understanding of Oregon's burning restrictions for waste application. Farmers may not be aware of biosolids unique procedures for field burn-offs. Albany's biosolid market's low volume and complexity may limit validity of the municipality's plans to market biosolids to grass seed farmers.

Receiving fertilizer material from a municipality poses some restrictions that farmers usually do not face; production is consistent year-round, whereas farming is inherently seasonal. Albany will only be able to deliver and apply biosolids twice a year: Spring and fall. Delivering and applying biosolids to farmers requires additional preparation, storage, and would further increase costs. It is necessary because without managing the delivery times, the value to farmers will be significantly diminished. Additionally, transportation and application are usually conducted through a third party, making it more difficult to control the quality of the service.

The timetable for the beginning of biosolids production increases the difficulty of constructing a mutually beneficial relationship between the city and grass seed farmers. Albany officials admitted that most likely the city will not be ready to do its first round of biosolids applications until the year 2020. This is both an opportunity and a hindrance, as it gives Albany several years to find a suitable partner, but also makes it less likely that a deal will be struck in the near future.

Recommendations

As has been noted, the City of Albany worked with the grass seed farmer community in the past, achieving the duel aim of providing a nutrient benefit to the farmers and allowing the city to dispose of a treated waste product. The city's positioning of such an offering will be critical to setting the cost to the city, subsidized and otherwise. Therefore, three approaches are recommended:

Business as Usual

In the past, Albany footed the entire bill. From treating the waste to transporting and applying the end product, the city provided a significant subsidy to the grass seed farmers that received the solids. In this way, the city avoided treatment and dumping fees, but incurred all costs associated with the benefit to the farmers. This imbalanced approach was expedient as it allowed farmers to become more familiar with a new way of fertilizing their fields. It also established a precedent that may prove a challenge to alter. Albany could continue business as usual by providing farmers free biosolids, while incurring infrastructure, transportation, and application costs.

The Middle Way

There is an opportunity to employ a market penetration strategy, relying on outreach and education, as farmers become more familiar with modern approaches to biosolids. Since Albany will have to find solutions for waste regardless of a partnership with the grass seed farmers, approach two is a bridge wherein farmers and the municipality work together to discover mutually beneficial and equitable supply relationships. Farmers might pay for the transportation and application, while the city continues pay for the infrastructure and supply the nutrient value for biosolids free of charge. Alternatively, the city could cover the transportation and application, while farmers pay market rates for the nutrient value of the applied solids.

The Brightest Future

Following wide adoption, in a higher demand market, Albany and other municipalities might be able to ask biosolids consumer (especially those requiring a more refined product) to help pay for the infrastructure improvements required to deliver such outputs. They might also charge a higher application fee to profit from the transportation and service to apply these nutrient rich amendments. Additionally, they could consider charging the market rate for the fertilizer benefits farmers would realize by offsetting their conventional fertilizer purchases with biosolids. In this way, the city could fully recover the costs of creating a value-add for agriculture. It should be noted that this final approach would require processed biosolids at a substantially higher volume than is currently available through Albany's output, meaning exploration of increasing supply through relationships with other regional municipalities may be beneficial.

Appendices

Appendix A: Farmer-facing questionnaire (for internal use) How do you currently source fertilizer?

How much do you pay per unit?

Are you aware that the City of Albany is planning to render Class A Biosolids out of its new wastewater treatment facility?

Have you ever used biosolids?

What are the advantages of using biosolids? What are the disadvantages?

What would make the use of biosolids more interesting/attractive to you?

- Type
- Cost
- Transport
- Storage
- What's the value to you? How much are you willing to pay for it?

What are the current regulations governing your application of fertilizer?

What are your fertilizer needs in tons?

How do you currently receive your fertilizers (shipping method)?

Do you apply the biosolids yourself, or do you require your supplier to apply the fertilizer?

What's the earliest in the season you can be ready to receive biosolids?

What form do you prefer to receive your biosolids in (cake, pellets, compost)?

In what way have the new burning regulations influenced your fertilizer choices?

Appendix B: Questions for city representative (Chris)

To whom may it concern,

As part of the University of Oregon's Sustainable City Year Program, our group we will be researching the potential markets for biosolids produced by the City of Albany. Our research parameter is quite narrow and our group's primary focus will be on the grass seeds farmers. Before we began our research however, our group would like to know about the City of Albany's biosolids program.

First, we would like to get some background information on the previous biosolids program. We would like to know how the biosolids program was being managed before and the reason for the program's closure. Some of the questions that we have are:

- When and why did the biosolids program end?
- What kind and how much of biosolids was the City of Albany producing before the program ended?
- Who received the biosolids previously?
- What was the feedback from the customers?
- What were the terms of the agreements between the customers for the biosolids?
- What were some of the problems that City of Albany encountered while managing its biosolids program?
- What system was in place before biosolids production?
- How were the deals structured and serviced?
- Why did this relationship stop?
- What is the ideal deal with grass farmers in the future?
- What volume of biosolids will you be producing, and on what timescale?
- What growers had a contract with you previously? Would they be interested in renewing?
- Were there problems previously that prevented more grass seed growers from using your fertilizer?

We will be focusing on grass seed for our research. If you have any information regarding biosolids and grass seeds farmers, we would like to know about them as well.

Next, we would like to look forward and get the sense of the current plans for biosolids at the City of Albany. Some of the questions that we have are:

- Why is City of Albany reviving its biosolids program?
- What type of biosolids does the City of Albany plan to produce?
- How much biosolids does the City of Albany plan to produce?
- What is the expected time table?

Thank you so much for taking the time to answer our group's questions.

Potential Biosolids Markets

Kathleen O'Melinn, Jeremy King, Anthony Lui, Chan Zhang,

Biyu Huang , Mayte Herrera-Cosby

Executive Summary

A study of farms near the City of Albany, Oregon, found the majority produce food. This study intended to learn about their use of biosolids. The researchers selected the agricultural market because of its dominance in the Oregon market.

Levels of awareness about biosolids and their regulations varied from farmer to farmer. It is recommended that the City of Albany consider partnerships with associations, pilot projects, and a joint education campaign around biosolids' benefits and uses to further explore the markets and their potential.

Conducting a Survey

We conducted primary research to learn about farmers' experience with biosolids. The questions asked were (Appendix A):

- Do you use biosolids?
- If so, in what capacity?
- Have you considered using them before? Why or why not?
- What would make them attractive for you to use?
- What are the challenges you have or can foresee?

Researchers collected responses in a google document available to city staff (Appendix B).

Markets Researched

Hop Farms

Farmers who were Contacted

Four Oregon farmers, out of ten, responded to attempts for contact.

Findings

Lack of information: From the responses received it was evident that farmers did not have knowledge of biosolids to answer questions asked.

Perception: Farmers were hesitant in replying because they perceived it as similar to sludge. The hop industry is increasingly concerned about food safety and food grade. Being a traditional industry, it is resistant to moving away from conventional farming practices. Education about biosolids, including both their ecological and economical benefits, could make them appealing.

Regulation: A response from The Oregon Hophouse emphasized another challenge of biosolid regulation. If biosolids are considered sewage sludge, they can not be used in organic farming because their regulations prohibit using sewage sludge.

Pear Farms

Farmers who were contacted

Researchers sent emails to seven pear farmers asking about use or contemplation of using biosolids to fertilize their crops and one response was received.

Findings

Previous contamination: A pear farmer, Mike McCarthy (Ph.D., Animal Science), used the biosolids to fertilize orchard grass hay used to feed his cattle. He reported 20 cows prolapsed after the application of biosolids, which had never happened before. He believed it was most likely due to contamination from the biosolids. When asked if there was anything that could convince him to reconsider using biosolids, he was not sure.

Dryland Wheat Farmers

Findings

Researchers only found dryland wheat farms with land for sale. In the future, it will be important to find an alternative way to contact farmers if interested in pursuing the dryland wheat market.

Blueberry Farms

Farmers who were contacted

Four blueberry farms were contacted because of their popularity in Oregon. The researchers spoke to two farms Green Hill Aire Blueberry Farm and Purcell's Blueberries.

Findings

Not needed: Green Hill Aire Blueberry farm only used water and sunlight to grow their blueberries. The representative was unaware of the benefits of biosolids but stated that the owners wanted to let the blueberries grow naturally.

Lack of information: Purcell's Blueberries did not know about biosolids. The representative said they used a special blend of fertilizer purchased from Wilco, but did not remember the name of the brand. Neither representative knew about biosolids, which suggests that more information could be shared about the benefits of biosolids.

Seasons: Researchers were unable to contact Royal Blueberries and Adkins Blueberry Farm because blueberry season had ended and they did not have a representative tending the phones.

Public contact: Based on responses from local farms we believe that the blueberry industry is not an ideal market for biosolids because they are usually picked by the public who cannot be in contact with biosolids due to safety concerns.

Christmas Trees Farms

Farmers who were contacted

Over 20 farmers were contacted, but only a few farms replied.

Findings

Lack of Information: Bystrom and Sandberg Trees wanted more information about the components of biosolids. They reported interest, but needed more information.

Certainty of fertilizer: A farm did not want to experiment with new products because in the past working with ineffective products interrupted their growing cycle significantly. Their perception of new fertilizers would only change if there was not enough supply of the fertilizer they currently use.

Water: One farmer said they only add water to their crops and will not consider using biosolids, or any other type of fertilizer because it costs money and the trees grow without it.

Benefits of Biosolids for Christmas Trees: Studies have shown that biosolids have the potential to increase the value of Christmas trees because organic nutrients improve a Christmas tree's height and look. This has also been seen in forest land reclamation projects.[1]

1 http://www.biosolids.com/benefits.html

Substitutes

Trends in the Biosolid Market

The market for biosolids might shift towards Class A Biosolids becasue they do not have restrictions on agricultural application, like Class B Biosolids.[2]

Comparing Fertilizer to Biosolids

Chemical fertilizers primarily consist of three nutrients, nitrogen, phosphorus, and potassium.[3] From small, household plantations, to large hundred acre farms, commercial fertilizers dominate the market because they are available and can be purchased at a relatively low cost.

Benefits of Marketing to Farmers

The production of Class A Biosolids has environmental benefits for farmers because biosolids have organic matter that improves crop growth and yield. Organic matter improves soil structure and absorption to store moisture.[4] Biosolids are generally less expensive for farmers because they have been provided for a minimal fee or free as they are introduced into the market. In 2006, a farmer in central Virginia claimed that he could save almost $200 per acre by switching to fertilizing with biosolids.[5] The increase in yield coupled with reduced production cost makes biosolids an attractive substitute to chemical fertilizers.

Challenges for Farmers Adopting Biosolids

There are health and safety concerns that could make it more difficult for farmers to switch to biosolids. According to the National Academy of Sciences (NAS), "the use of these materials [biosolids] in the production of crops for human consumption when practiced in accordance with existing federal guidelines and regulations, presents negligible risk to the consumer, to crop production and to the environment."

2 https://www.epa.gov/sites/production/files/2015-05/documents/a_plain_english_guide_to_the_epa_part_503_biosolids_rule.pdf

3 http://lystek.com/biofertilizers-vs-synthetic-chemical-fertilizers/

4 https://www.epa.gov/sites/production/files/2015-07/documents/biosolids_generation_use_disposal_in_u.s_1999.pdf

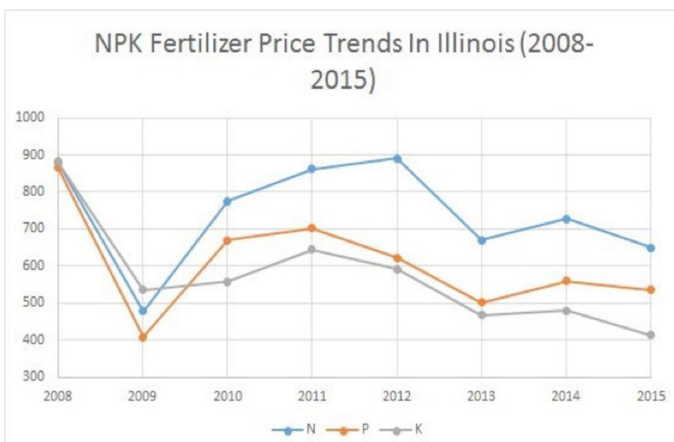
5 http://www.pwea.org/docs/biosolids-a-low-cost-fertilizer-option.pdf

Bob Schroeder from Crop Production Services (CPS) stated that the two most important factors for farmers are the cost and safety of biosolids. If farmers are not comfortable with the cost and safety of biosolids they will continue using commercial fertilizers because it has worked effectively for them.

CPS works with farmers across the country to provide information regarding various products and services that seek to maximize the potential of each farm.[6] From selling seeds to sampling the soil and fertilizer application, CPS serves as an expert in the field.

Fluctuations in Price and Influences

While chemical fertilizers are available and inexpensive, the costs can fluctuate in price. The University of Illinois studied trends in prices of nitrogen, phosphorus, and potassium (NPK) fertilizer in Illinois from 2008 to 2015. Prices fluctuated for all three types of fertilizers, ranging from a low of $408/ton of diammonium phosphate (DAP) in 2009 to a high of $891/ton of anhydrous ammonia in 2012. Natural gas is a major ingredient in many commercial fertilizers. Its fluctuating availability and price cause fertilizers price fluctuation. In 2015, fertilizer prices were $650, $536, and $414 per ton for anhydrous ammonia, DAP, and potash, respectively. Volatility with future supply and demand of natural gas may make chemical fertilizers more expensive, and therefore, increase future demand for biosolids.



6 http://www.cpsagu.com/about-cps

Lessons Learned

This report demonstrates the challenges of contacting farmers. When contacted, farmers did not recognize the term biosolid. For future projects, the City of Albany should share in-depth information about the future of biosolids in Albany before contact is attempted with farmers. Project researchers could then answer basic questions and introductions to biosolid processes and benefit.

It will take time for farmers to adopt biosolids. Currently, the market demand for biosolids is unclear. Based on our research the Christmas tree market has the most potential due to number of growers in Oregon and fewer regulations. Biosolids also offer a clear benefit because it produces greener and larger trees, leading to higher sale prices.

Recommendations

Create strategic partnerships with trade associations

It is important to build partnerships with trade associations rather than individual farmers because:

- It may enhance how farmers perceive the City of Albany's biosolid project. It may be faster to build trust with farmers and observe the current biosolid market through the association.
- The associations have current information about farms and their operations. Currently some farmers have a safety concern and the association may be able to contact and educate them through different channels.
- The association can explain the short- and long-term benefits of using biosolids. They will be able to explain how biosolids can directly benefit crops.
- The city will be able to increase long-standing relationships with agricultural organizations as well as farmers.

Examples of trade associations and organizations to contact are:

Pacific Northwest Christmas Tree Association

It was established in 1955 and its goal is to conduct research, educate and create environmental stewardship for all the industry and the public.[7]

SERF Certified (Socially & Environmentally Responsible Farm)

Farmers can use biosolids in their growing process and be SERF certified. Farmers attempting to gain SERF certification will need to document how they use biosolid fertilizer. SERF does not require or recommend certain fertilizers for farmers to use. For farms to grow SERF certified trees they must meet a certain sustainability standard to protect land, water, communities, and wildlife. The biosolids project and SERF's goals are similar and align well because they are trying to improve the soil composition for more sustainable farming practices.[8]

Crop Production Services

Crop Production Services (CPS) is more than just a provider of agricultural input. Farmers across the country use CPS's services to enhance their own agricultural outputs. CPS has a broad reach to individual farms in Albany and can be the point of contact for introducing biosolids as a potential substitute for conventional fertilizers. Bob, a sales representative from CPS, has expressed interest in trying biosolids. However, his main concerns are cost and safety. The cost of biosolids needs to be competitive with commercial fertilizers and provide the same or better benefits. It is also vital to prove that biosolids are safe for the public before organizations like CPS would consider trying biosolids.

The next step after building relationships with associations and key organizations is to further define the market. This could be done through a survey with the help of partners to collect an appropriate sample size. Albany could also publish content through their media channels like the Christmas Tree Lookout. It is a popular magazine published three times per year that provides information to farmers about different events and activities. Over 1,000 farmers receive it in Oregon and Washington.[9]

7 www.pnwcta.org

8 http://www.pnwcta.org/serf/

9 http://www.pnwcta.org/member-resources/publications/christmas-tree-lookout/

Education: Explaining Biosolids

Education was the most commonly cited reason farmers had not used biosolids. We recommend:

- Conducting pilot projects to show the benefits to farmers. It could be on a portion of the farm that uses fertilizers to allow direct comparison between biosolids and fertilizers.
- Creating easy to read material for farmers to assist them in understanding the process and procedures of biosolids. It will also be important for them to know about the support that will be there if they need help while implementing.
- Creating content to help improve the public image of biosolids targeted especially for the public. Public education could create consumer demand over time, as demonstrated by the organic movement.
- Attend events to connect with sellers and buyers:
  - Christmas Tree Fair and Trade Show
  - WEF (Water Environment Federation) Residuals & Biosolids Conference

Conclusion

In the survey, farmers presented opinions of biosolids suggesting lack of information and negative perceptions. The City of Albany will need to overcome several challenges to create a pivot in the farming practices used in Oregon. Education, partnerships, and pilot projects are all needed to show farmers the benefits of switching to biosolids use as a fertilizer for their crops.

Appendices:

Appendix A: Farmer Contacts

An Excel spreadsheet was created listing all the farmers, their market, their contact information, and if they responded.

https://docs.google.com/spreadsheets/d/1z5zfTKWKQt06gxHWbzmXr6LkIIEh_CYndx1BZgsew gI/edit#gid=0

Below is a more detailed response of how farmers responded to the questions sent via e-mail.

Farmers who were contacted were asked:

1. Do you use biosolids? If so, in what capacity?

2. Have you considered using them before? Why or why not?

3. What would make them attractive for you to use?

4. What are the challenges you have or can foresee?

Appendix B: Farmer Responses

Hop Farms Responses

1. Crosby Farms

- "We do not currently use biosolids. We have not considered using them to my knowledge. I think the farmers here don't have enough information about biosolids and would be hesitant based on their perceived similarity to sludge. The challenge I see is that the hop industry is increasingly trending toward food safety/food grade, while at the same time remains traditional and resistant to change as far as conventional farming practices go. I think education around biosolids, including both ecological and economical benefits, would make them more appealing."

2. Smith Rock Farms

- "Can you give me a few more details on the makeup of the biosolids? We currently use an NPK mix, ash from our burn pile, and alpaca manure on our field."

3. Oregon Hophouse

- "We grow non-organic and organic hops. If biosolids are sewage sludge, we do not use them. Organic rules prohibit using sewage sludge. I know biosolids need to be put somewhere but they probably need to be refined first so that there can be better control over what is exactly in them."

Christmas Tree Farmer

4. Bystrom and Sandberg Trees

- "You need to explain what a biosolid is, and what the chemical (nitrogen etc.) contents are supposed to be, and then maybe you will get some responses. I am 98% sure we are too far away (Molalla, OR) to make it feasible for delivery. We do fertilize Christmas trees the last few years to get the "green" in them. This sounds like a great idea, but you need to do a little more explaining of what you are trying to market."

5. Brooks Tree Farm

- Are you aware the City of Albany is planning to render Class A Biosolids out of its new wastewater treatment facility? "No."
- Have you ever used biosolids? No. If so, why did you? If not, why? "We have fine-tuned a program for fertilization and prefer to not experiment. We have experimented with changes in the past, and have many, many opportunities to do so again. But we've had problems that range from ineffective all the way to disasters with alternate products."
- What would make the use of biosolids more interesting/attractive to you? "Really nothing short of a lack of current product would cause us to consider a change."

6. Beal Christmas Tree Farm

"Thank you for your email. Unfortunately, this is the time of year that we have the least amount of extra time to do anything but harvest and sell our Christmas trees. I'm sorry we cannot help you with your research at this time. Best of luck to you."

Environmental Benefits of Biosolids Application

Savannah Bagley, Joey Jaraczewski, Jessica Wang

Executive Summary

The City of Albany, Oregon, is considering introducing a biosolid treatment program at their wastewater treatment plant. If implemented, the waste would be diverted from the landfill and repurposed as natural fertilizer. As a byproduct of human activity, biosolids can be processed into a convenient fertilizer and soil-builder for crops, a tool to restore exhausted land, and as a vehicle for reducing greenhouse gases in the atmosphere. There are some risks inherent with the use of biosolids including the introduction of trace metals, pathogens, and excess nitrogen into the soil. This report hopes to inform policymakers and waste treatment personnel about the environmental benefits that could be realized from increased integration of biosolids into the residential, commercial, and industrial ecosystem of Albany. This paper focuses on four key areas that benefit from the use of biosolids: Soil, agriculture, forestry, and land reclamation.

Introduction to Biosolids

Over the last few decades, municipalities across the Pacific Northwest have developed a heightened consciousness of their role in the resource cycle. Other regions commonly consider waste management and water treatment programs as a cost center. Meanwhile, county authorities across Oregon and Washington use these programs to generate value-added materials for industrial and residential applications. By processing sewage waste into Class A and Class B Biosolids, these programs realize simultaneous environmental and economic gains from the beneficial use of these value-added materials (See Table 1: Value-added applications for biosolids production).

King County, Washington, defines a beneficial use of a material as, "any [use] that proves to be environmentally safe, economically sound, and utilizes the advantageous qualities of the material."[1] In this paper, we restrict the environmental benefits to land-based applications of biosolids. This focus led to a greater understanding of the effects of biosolid application on soil health. The environmental benefits derived from soil health are different depending

1 Wastewater Treatment Division, King County Dept of Natural Resources and Parks. Alternative Uses And Market Opportunities For Biosolids. King County: King County Council, 2009.

on their application. We consider biosolid usage in agricultural operations, commercial and conservation forestry, and land reclamation projects. In each section, we outline a range of documented benefits that biosolids can generate, and conduct research on select topics.

Table 1: Value-added applications for biosolids production:[2]

- Class B Dewatered Biosolids
  - Dewatered, stabilized through an industrial digestion process
  - Reduction of harmful pathogens and vector/pest attractants
  - Eligible for industrial application, with strict provisions of use[3]
- Class A Composted Biosolids
  - Dewatered, stabilized through an industrial digestion process and composted
  - Considered “pathogen-free”
  - Eligible for industrial, commercial, residential application with few restrictions
- Class A Lime-stabilized Biosolids
  - Dewatered, stabilized through an industrial aeration process
  - Addition of alkaline agent to manage soil pH levels
  - Primarily used for agricultural programs, displacing synthetic amendments
- Class A Thermally Dried Biosolid Pellets
  - Dewatered, stabilized through an industrial aeration process
  - Thermal drying and tumbling system for pelletization
  - Primarily used for agricultural programs, displacing synthetic fertilizer pellets

2 City of Everett. Strategic Plan For Biosolids Management. Everett: HDR Engineering, Inc., 2012.

3 U.S. Government Publishing Office. Title 40, Protection Of Environment, Chapter I, Subchapter O, Part 503. Environmental Protection Agency, 2016.

Effects on Soils

In the current era, there is significant overlap between human activity and natural processes. It is sometimes hard to identify the common links between human and natural systems. Studying soil offers a convenient indicator, where the health of human and natural activities is dependent on the health of local soils. Soil health is characterized by:

- The prevalence of biodiversity through microbial life
- The prevalence of biodiversity through beneficial fungi
- The formation and stability of habitats for complex organisms (wildlife)
- The diverse composition of soil material, including nutrient-dense organic matter

Due to certain processes and practices, many soil systems are deficient in biodiversity, wildlife, and nutrient-dense matter. In conventional circumstances, these deficiencies are noted only for their poor aesthetic value. However, once recognized these indicators of soil health provide significant environmental benefits to community and industry, proactive maintenance of local soils becomes akin to long-term investments in economic resilience. These "ecosystem services" can be broadly defined in terms of their contribution to air quality, water quality, and land value.

In general, the "ecosystem services" provided by healthy soils descend from the vegetative growth that they promote. Wild plants and commercial crops draw carbon from the atmosphere and store it in the soils through their life processes. Because of this process of "carbon sequestration," vegetative growth contributes to increasing local air quality and lowering a municipality's carbon footprint. The level of carbon sequestration depends on the application of biosolids, where long-term vegetative growth projects like land reclamation will have a larger net effect than will short-term agricultural projects with seasonal harvests.

Vegetative growth in healthy soils contributes to water quality as well. Beyond providing structural support for plants, the soils also "provide water absorption, which allows for supply of water to plant roots, groundwater, and surface water."[4] Using biosolids to increase the level of organic matter in the soil's composition causes the soil to retain more water while offering more complete

4 David Evans and Associates, Inc., ECONorthwest. Comparative Valuation Of Ecosystem Services: Lents Project Case Study. City of Portland: Watershed Management Program, 2004.

plant nutrition. This translates to yield gains, greater drought resilience, and decreased reliance on irrigation and chemical fertilizers. Meanwhile, the cycle of water through these healthy soils has downstream effects on the purity and quality of water for use in residential, commercial, and conservation applications.

Furthermore, biosolids fertilizer has a lower net effect on nutrient runoff than with commercial synthetic fertilizers. While both fertilizers provide effective nutrition for vegetative growth, biosolids do so with the addition of organic matter. Biosolids provide a replacement for lost or compacted topsoil, especially when plowed under the surface of the existing soil. The organic matter that enters the soil from the biosolids aerates the soil due to the gradual development of a soil ecosystem. The organic matter effectively binds the nutrients essential for plant growth—nitrogen, phosphorus, potassium, sulphur, zinc, boron—to the plant root zone much longer than with traditional, inorganic fertilizers.

By increasing the health of the soils, the effectiveness of ecosystem services is increased for a variety of land-based economic activities. Ecosystem services have positive effects on the human condition. Soil health has downstream effects on human health through the quality of food and water, but the vegetative growth and resulting habitat formation have an aesthetic value that is more easily quantified. In a related case, the City of Portland reclaimed land by using Class A Biosolids to install a “riparian zone” in a stream rather than building a new water treatment plant. A riparian zone is an intentional habitat created in a waterway that purifies water through natural processes, while doubling as a wetland to prevent stormwater flooding. A side-effect of installing the riparian zone was a rise in real estate valuation due to natural beautification.[5]

5 David Evans and Associates, Inc., ECONorthwest. Comparative Valuation Of Ecosystem Services: Lents Project Case Study. City of Portland: Watershed Management Program, 2004.

Effects on Agriculture

Agriculture is a major driver of Albany's economy. Agricultural operations around Albany are net exporters of grass seed, while other prominent crops include corn, beans, mint, strawberries, and hazelnuts.[6] Between 2008 and 2009, Albany distributed its total biosolid production to rye grass and pasture. However, Class A and Class B Biosolids have been successfully deployed as a fertilizer and soil amendment for a variety of agricultural operations. The ecosystem services resulting from application of biosolids fertilizer are:

- Increased yields through more efficient nutrient cycling
- Increased yields through increased soil biodiversity
- Reduced emissions due to reduced support of chemical fertilizer industries
- Increased drought resilience through increased soil moisture
- Decreased wind erosion through increased soil moisture and diverse soil composition
- Social benefits due to local project management of biosolids integration[7]

Yield gains through soil fertility

The method of fertilizing a cropping program with biosolids depends largely on the crop grown. As a dry fertilizer, dewatered biosolids are typically applied with calibrated manure spreaders and are then tilled directly into the soil. Meanwhile, liquid biosolids can be sprayed onto the land or injected below the soil's surface.[8] Regardless of the specific application method, biosolids are proven to generate multi-year increases in yields and moisture retention. Researchers at the University of Nebraska-Lancaster demonstrated that yield gains are due to the reparation of nutrient deficiencies in conventional soils, alongside the buildup of organic matter and microbial life in the soil.[9]

6 "Albany, Oregon". En.wikipedia.org. N.p., 2016. Web. 27 Nov. 2016.

7 Wastewater Treatment Division, King County Dept of Natural Resources and Parks. Alternative Uses And Market Opportunities For Biosolids. King County: King County Council, 2009.

8 Ibid.

The success of an application program depends largely on the completeness of integration into the crop's industrial community. Researchers at Washington State University-Prosser demonstrated a ten percent increase in corn yields for fields fertilized with biosolids.[10] Farming cooperatives in Douglas and Yakima Counties developed programs for purchasing and applying biosolids fertilizers. Together, they use 70% of King County's municipal capacity for application to wheat, hops, canola, and grape cropping programs.[11] This type of community engagement with biosolids programs doubles as a form of social sustainability, and is recognized as an environmental benefit (Exhibit 1: Allocation of King County biosolids to various industrial purposes, 2009).

Reduced emissions through local processing and transportation

Modern agricultural practices typically consume a range of synthetic fertilizers in order to provide the nutrients for plant growth. This type of activity increases the carbon footprint of the operation substantially. First, the synthetic fertilizers generate greenhouse gas (GHG) emissions through extraction and manufacture of raw chemical ingredients. Second, the synthetic fertilizers generate emissions through transportation to the industrial consumer. Third, synthetic fertilizers become an emitter of nitrous oxide, a more potent GHG in comparison to carbon dioxide, once they are applied in the field.[12]

King County has shown that the use of biosolids fertilizers has a positive carbon value in direct comparison to synthetic fertilizers. Biosolid fertilizers generate less GHG emissions during manufacture since they are processed in a closed system—especially if the manufacturing system includes an anaerobic digester. Moreover, transportation emissions are mitigated due to the locality of water treatment plants to industrial agricultural consumers. Additional emissions are offset by the carbon sequestering effect of biosolids fertilization. The risk of emitting nitrous oxide in the field does remain with biosolids fertilizers, but that risk can be reduced through careful fertilization planning.[13]

We can assume that each dry-ton of biosolids fertilizer applied will offset the equivalent of 0.29 metric tons of CO2 emissions (mtCO2e) from synthetic

9 Ogg, Barb. Fertilizing With Biosolids. Nebraska Extension in Lancaster County: University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, 2016.

10 Sullivan, Dan, Craig Cogger, and Andy Bary. Fertilizing With Biosolids. Pacific Northwest Extension, Oregon State University, University of Idaho, Washington State University, 2007: 9.

11 Wastewater Treatment Division, King County Dept of Natural Resources and Parks. Alternative Uses And Market Opportunities For Biosolids. King County: King County Council, 2009: 2, 8.

12 Park, S. et al. "Trends And Seasonal Cycles In The Isotopic Composition Of Nitrous Oxide Since 1940". Nature Geoscience 5.4 (2012): 261-265.

13 Wastewater Treatment Division, King County Dept of Natural Resources and Parks. Alternative Uses And Market Opportunities For Biosolids. King County: King County Council, 2009: 42

fertilizer production. That same dry-ton will sequester 2.0 mtCO2e into soil storage. The dry-ton of biosolids fertilizer will emit 0.135 mtCO2e from the diesel expended in order to transport and apply the fertilizer, resulting in a net “carbon capture” of 2.16 mtCO2e (see Exhibit 2: Carbon credits/debits for biosolids application in various contexts).

Effects on Forestry

Although the local timber industry is in a state of decline, Albany has historically played host to a forest economy. That legacy remains in the city’s long-term investment in its Urban Forest. Albany’s Urban Forest is recognized by Tree City, USA as having spent at least two dollars per capita on maintenance and improvements to its Urban Forest.[14] In a larger context, forests cover approximately 70% of Linn County, while ten percent of those forests are managed privately.[15] Forests provide a wellspring of ecosystem services, from increases in air quality to intricate improvements in water quality. The following studies have mostly been applied to commercial or residential tree plantings. However, these findings may also be appropriate for use in forests set aside for conservation as well. Effective applications of biosolids to forest lands and timber resources can enhance the quality of these ecosystem services through:

- Increased yields through more efficient nutrient cycling
- Increased yields through diverse soil composition
- Increased biodiversity due to habitat formation

14 Oregon Departments of Forestry. Urban Forests. Urban & Community Forestry Program, Private Forests Division, 2016.

15 “Forestry & Natural Resources Program”. OSU Extension Service - Linn County. N.p., 2016. Web.

Forest yield gains due to soil fertility

There is a long case history of benefits to yields through biosolids fertilization. It has been shown that most tree species will simply grow faster when biosolids are introduced into their care program. One of the most common trees in the Pacific Northwest, the Douglas Fir, has been shown to grow up to 75% faster in controlled tests.[16] Meanwhile, Christmas trees will not only grow faster, but fuller and greener.

In comparison with agriculture, biosolids used in forest applications are more effective at fertilization. This is due to the longer lifecycle of the crop. When biosolids are applied, there is more nitrogen released over time when compared to conventional fertilizers. The trees respond to this increase in nitrogen by allocating it towards foliage growth. This tends to increase foliar biomass, which tends to increase tree stem growth.[17] For example, researchers in Virginia used a mechanical spreader to apply Class A Biosolids to a stand of pine in a controlled experiment. The increased nitrogen content of the biosolids-grown pine stand showed a four-fold increase of dry matter (pine needles) over the control stand. Furthermore, they showed that this increase in growth was evident across Class A, and Class A Lime-stabilized, and Class A Pelletized Biosolids[18] (see Exhibit 3: Effect of biosolids application on foliage dry matter in Virginia Forests).

There are some risks inherent to biosolids-grown forests. The accelerated growth of the tree crop has the effect of reducing the density of the tree stem. The density of biosolids-grown trees decreases by up to 15% in comparison to conventionally-grown trees. However, it is important to note that this reduction in density does not create an inferior tree. The mature trees are still within the strength rating of their conventional counterparts.[19]

16 "NBMA - Biosolids Facts - Forestry". Nwbiosolids.org. N.p., 2016.

17 Arellano, Eduardo and Thomas Fox. Effect Of Biosolids On A Loblolly Pine Plantation Forest In The Virginia Piedmont. Metropolitan Washington Council of Governments: N.p., 2005.

18 Ibid.

19 "NBMA - Biosolids Facts - Forestry". Nwbiosolids.org. N.p., 2016.

Soil fertility and biodiversity gains in forestry contexts

It is not only the trees that benefit from the increase in available nitrogen, but the entire forest system. The fertility of the soil also increases the growth rate of understory plants. This includes weeds, which was shown in the Virginia study to be detrimental to the growth of pine trees. However, this increase in a nutrient-rich understory plants does translate to an increase in complex and microbial life.

Within the soil itself, the organic matter and nitrogen content of biosolids causes an increase in microbial life and beneficial fungi. This is due in part to the increased biomass caused by the increased growth rate of fertilized trees. The biomass provides a home for the microbes and fungi, who feed the tree's growth in turn. Numerous studies have documented these "positive feedbacks among tree growth, soil nutrients, and microbial activity," where a more effective biosolids fertilizer provides a net benefit to the forest ecosystem.[20]

Meanwhile, the explosion of growth in the understory provides more sustenance for wildlife, alongside better hiding cover for habitat formation. Some have reported increases in complex life forms within biosolids-fertilized forests. Please note that these claims have been made anecdotally, and have not been validated by any rigorous study.

Effects on Land Reclamation

Land reclamation

Industrial activity has an exhaustive effect on the land. Timber production and agriculture have been covered in this paper. However, mining activity, construction activity, wetland displacement, and road site preparation all involve intensive processes which remove topsoil. When the land has no topsoil, vegetative growth is prevented and erosion quickens. Topsoil is built up over a long period of seasonal growth and decay to build organic matter in which a microbial ecosystem can thrive. As such, the land may never recover from mining or construction activities since the land has become impermeable to root penetration.

20 Brooks, J.P., C.P. Gerba, and I.L. Pepper. "Diversity Of Aerosolized Bacteria During Land Application Of Biosolids". Journal of Applied Microbiology 103.5 (2007): 1779-1790. Brown, Sally. Biosolids And Wildlife. University of Washington. Print.

Biosolids are an important tool for land reclamation due to their low cost and high nutrition for plant growth. They are also complementary to existing biosolids distribution programs since their annual tonnage need is much lower than that of agricultural production. The application of biosolids in reclamation contexts has similar environmental benefits to those that are found in agricultural or forestry contexts. Because of this, the commentary in this section is restricted to gains in biodiversity. However, since land reclamation projects have a longer life cycle, the environmental benefits are magnified:

- Increased air quality due to long term carbon storage
- Increased air quality due to decreased transportation emissions
- Increases in biodiversity due to greater vegetative growth
- Increased water quality due to wetlands restoration

Biodiversity gains through wildlife habitat enhancement

Following biosolids fertilization, reclamation projects have a longer working life in comparison to agriculture or forestry. This is simply due to the goal of vegetative growth; where agricultural applications require an assurance of annual yields, reclamation projects require the return of long-term vegetative growth.

As such, reclamation projects are predisposed towards selecting plant varieties that mirror the land in its natural state. Numerous projects, including the reclamation of a copper mining site in Kamloops, British Columbia, reclaimed land by reintroducing native grasses and flowering species. These types of perennial plants have a long-term sequestration effect. More importantly, they provide a natural habitat for native species to inhabit and thrive.[21]

Due to this potential increase in wildlife, stakeholders often voice a concern over the safety of wildlife coming into contact with biosolids. They question the effect of human pathogens on animal life. Biosolids also contain concentrations of metals and organic matter that are great for plant growth, but may be detrimental to animal health. Moreover, the EPA even provides regulations for processing Class A and Class B Biosolids to reduce their level of "vector," or rodent, attractants.[22]

21 Wastewater Treatment Division, King County Dept of Natural Resources and Parks. Alternative Uses And Market Opportunities For Biosolids. King County: King County Council, 2009: 12

22 U.S. Environmental Protection Agency, Bastian, Robert. Biosolids Management Handbook. Washington, D.C. 2016. Print.

The largest concern with reclamation efforts is not necessarily with the biosolids themselves. Again, biosolids contribute to the growth of soils and vegetation on exhausted land. This exhausted land then becomes a habitat for animal life. A significant concern with this arrangement is in the form of “attractive nuisances,” or the presence of biohazardous waste or contaminants left behind from industrial processes. For example, a mining operation exposes heavy metals, which may become ingested in trace amounts by wildlife. These trace amounts can remain in an animal’s digestive system and concentrate to lethal quantities as animals are consumed in the food chain. This process is called the “bioaccumulation” of harmful substance.[23]

This topic has been studied at least once in peer review. Toxicologists from the EPA’s Environmental Response team tested the effects of reclamation on wildlife following biosolids reclamation at industrial sites in Idaho, Missouri, Pennsylvania, and Colorado. At the level of the soil ecosystem, the researchers found a stable, healthy population of earthworms. Despite living in the presence of cadmium levels exceeding that deemed safe by regulation, the population existed within a normal range of cadmium in their biological systems. Meanwhile, the team tested the kidneys and livers of small mammals that returned to inhabit the reclamation sites. The team found that less than 10% showed any signs of cellular changes to their organs. The cellular changes that did manifest themselves were insufficient to compromise organ function.[24]

Since biosolids are commonly applied in reclamation contexts that follow industrial activity, more research must be performed on the effect of trace elements on the return of wildlife. However, there is a strong regulatory framework to govern and prevent extensive damage to animal populations.

Conclusion

Biosolids fertilization provides economic value to rural communities by complementing industries that drive rural economies—agricultural production, commercial and conservation forestry, and resource extraction. When applied correctly, biosolids benefit soil health, increase yield gains, increase water and air quality, and increase biodiversity due to habitat formation.

23 Environmental Protection Agency. Ecological Revitalization And Attractive Nuisance Issues. United States: N.p., 2016. Print.

Appendices

Appendix A: Allocation of municipal biosolids to various industrial purposes, King County (2009)

Table 1. Average Current Distribution of King County Biosolids

Project Name	Uses/Crops	Customers	Location	Average Annual Use (wet tons)	% of Total Annual Production
Boulder Park	Dryland wheat	Farmers	Douglas	65,000	57%
Natural Selection Farms	Canola, hops, misc. crops	Farmers	Yakima	15,000	13%
Hancock - Snoqualmie Forest	Commercial forests	Forest management company	King	25,000	22%
State Department of Natural Resources (WA DNR)	Commercial forests	State forest management agency	King	5,000	4%
GroCo	Compost product (Class A, Exceptional Quality biosolids product)	Landscapers and general public	King	5,000	4%
		Total Annual Production		115,000	

Appendix B: Carbon credits/debits for biosolids applicationin various contexts, King County (2009)

Table C-1. Results of carbon accounting for RFI proposals

			Carbon Credits Per Dry-Ton				Carbon Debits Per Dry-Ton					
			Replacement Of Synthetic Fertilizer	Accumulation Of Carbon In Soil	Displacement Of Fossil Fuels	Displace Material In Cement Manufacture	Energy Required to Dry	Diesel Burned to Transport Biosolids to End-Use Site		Diesel Burned For Application Of Biosolids	Emission Of Nitrous Oxide	Credit Per Dry-Ton
Vendor	Technology	Basis for Values	Metric tons (Mt) CO2	Mt CO2	Mt CO2	Mt CO2		Distance (miles)	Emissions Mt CO2	Emissions Mt CO2	Emissions Mt CO2	Metric tons (Mt) CO2
Boulder Park	Agriculture - Dryland grain crops, reduced till	UW/WSU data from KC field site	0.29	2.00	0.00	0.0		400	(0.120)	(0.015)	0.000	2.16
GroCo	Compost - Aerated static pile	UW/WSU data from KC field site	0.29	0.78	0.00	0.0		60	(0.018)	0.000	0.000	1.05
Natural Selection Farms	Agriculture - Agronomic crops, hops, and rangeland	UW/WSU data from KC field site	0.29	2.00	0.00	0.0		400	(0.120)	(0.015)	0.000	2.16
Ramco	Forest application	UW/WSU data from KC field site	0.32	2.00	0.00	0.0		60	(0.018)	(0.015)	0.000	2.29

Appendix 3: Effect of biosolids application on foliage dry matter in Virginia Forests, Arellano and Fox (2005)

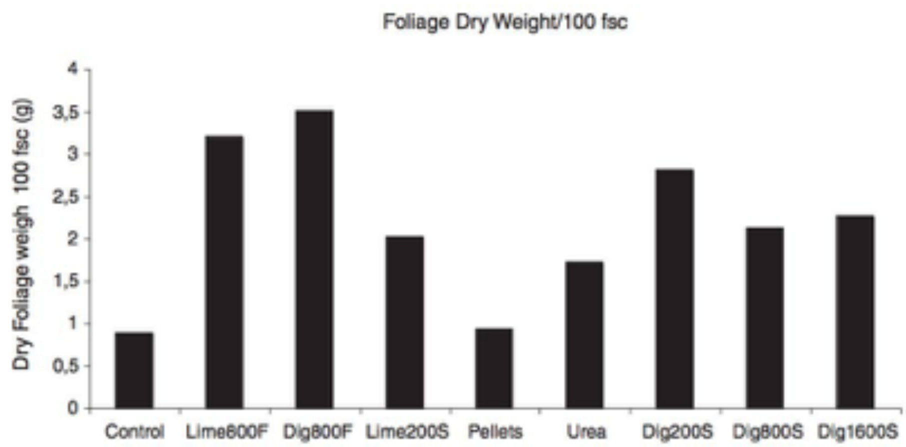


Figure 3—Total foliage dry mass of 100 needles sampled from a loblolly pine plantation in the Virginia Piedmont following treatment applications during November 2005 and March 2006. The first treatment applications were at one rate of anaerobically digested and lime stabilized biosolids (800 pounds per acre of PAN). The second treatment applications were at three different rates of anaerobically digested biosolid (200, 800, and 1600 pounds per acre PAN) and one application rate (200 pounds per acre PAN) of lime stabilized, pelletized biosolids, and a conventional urea + DAP treatment. Results are reported in mg/100 fascicles.

Best Practices for Biosolids Programs

Sarah Rausch, Katie Hairston, Lexi Zhu

Summary

We evaluated wastewater treatment facilities currently involved in the production of Class A and B Biosolids. Through analyzing current operations at other municipalities, we provide the City of Albany with case studies of other wastewater treatment facilities producing biosolids. We researched treatment facilities similar in location and community size, and those with different biosolid classification, application, and public-private partnership structures.

City of Everett, Washington

The City of Everett is a member of the Northwest Biosolids Management Association (NBMA), which provides collaborative research, technical assistance, and public information for biosolids managers in the region. They use four different categories of biosolids, which are Class A Composted Biosolids, Class A Lime-stabilization Biosolids, Class A Dried Biosolids Pellets, and Class B Dewatered Biosolids. Everett also partners with the Environmental Protection Agency (EPA), who sets quality limits for trace metals and requires pathogen and odor reduction.

City of Centralia, Washington

Also a member of the NWBA, Centralia's wastewater treatment plant is the smallest operation studied, serving about 16,000 people. Despite its small size, the facility has a successful Class A Biosolids program. The compost is available for consumer use and can be obtained at either the facility location or a satellite "self-haul" site. Centralia does not partner with another organization to provide this service.

King County, Washington

King County is also a member of the NWBA and runs a wastewater treatment facility that serves the greater Seattle area. They produce 120,000 tons of Class B Biosolids annually. A portion of those biosolids are composted by a private company and sold as Class A Compost GroCo® for utilization in gardens and landscaping. King County has also established ongoing partnerships with Mountains to Sound Greenway Trust, Boulder Park Inc., and Natural Selections Farms Inc. to build sustainable and beneficial programs utilizing biosolids.

Spokane County, Washington

Spokane County is a member of the NBMA and the facility produces Class B Biosolids. Spokane County contracts with a private company for further processing of their biosolids into Class A Compost. Both the City of Spokane and Spokane County operate wastewater treatment plants and produce Class B Biosolids as the area demand is greater than supply. CH2M Hill & Barr Tech partner with Spokane County to further treat the biosolids to required levels.

Orange County, California

The Orange County Sanitation District (OCSD) treats the water by removing the solid particles and treating the solids with heat and beneficial microbes that digest the germs and create bio-gas. They use the bio-gas to generate electricity to power their treatment plant. In addition, their biosolids recycling sequesters almost 13,000 tons of carbon dioxide equivalents, which means they confine the carbon in the soil, keeping it from being burned as a greenhouse gas. OCSD is part of the National Biosolids Partnership (NBP) and is responsible for their full biosolid's value chain, attendance at training workshops, and must be verified by a third party, and share information. OCSD partners with the Water Environment Federation (WEF), National Association of Clean Water Agencies (NACWA), and the EPA.

Solano County, California

Solano County's biosolid program is working with unique partners to explore how biosolids can be used as a renewable energy resource. The Bay Area Clean Water Agency (BACWA) is working with Bay Area Biosolids to Energy Coalition (BAB2E) to develop options for Bay Area biosolid use as a renewable energy resource. BAB2E pursues a multi-pronged approach that includes advocacy for regulations and funding to foster technology solutions and project implementation, solicitations to identify ready-to-implement, commercial-scale projects, and technology incubation. They also foster technology research and development through facilitating partnerships and hosting demonstration projects.

Lee County, Florida

Not only does Lee County process both Class A and B Biosolids, but Lee County also further processes their biosolids to create a Class AA Biosolid. It is the safest and most marketable level of this product. They sell this AA fertilizer as OrganicLee® compost for $10 per cubic feet. Lee County has grown acceptance for this product, as their OrganicLee® compost sells out for five months out of the year. The Lee County Utilities Division share a co-composter and has a facility. Hazen and Sawyer, an engineering firm, partnered with Lee County to create the biosolid management plan. The University of Florida is completing research to improve acceptance of the use of biosolids. OrganicLee® is used by Roots Heritage Garden, Lee County Parks, Ft Myers Women's Shelter, and the Child Care Center. Albany could investigate implementing this strategy into their biosolids processing to generate revenue to their existing plans.

Lancaster Area Sewer Authority (LASA), Pennsylvania

Similar to Albany, the LASA region has a relatively small population compared to other municipalities. They serve approximately 100,000 residents and 1,300 businesses. Since they're such a small organization, they hire an external industrial facility to pretreat the wastewater prior to LASA's processing. Rettew, AECOM, and Material Matters all created a biosolid management report for LASA. KCI Engineering created a biosolid study to evaluate, confirm, and update to support the project. Buchart Horn, an engineering and architectural firm, completed a basis of design report, including more specific cost information.

Figure 1 gives a brief overview of each researched municipality's population, biosolid production, and information regarding whether it's a public or private program.

County	Population Served	MGD Production *	Public or Private?
Centralia (WA)	16,000	2.7 MDG	Public
City of Everett (WA)	105,000	36.3 MGD	Public
King County (WA)	2,044,000	175 MGD	Public, w/ a private partnership
Spokane County (WA)	479,000	34 MGD	Public, w/ a private partnership
Orange County (CA)	3,114,000	53 MGD	Public
Solano County (CA)	435,000	12.2 MGD	Public
Lee County (FL)	661,000	29.5 MGD	Public
Lancaster Area Sewer Authority (PA)	100,000	15 MDG	Public, w/ a private partnership

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Figure 1: Case studies' population, production, and partnership status

Figure 2 shows the classifications and uses of the biosolids produced in each of the researched regions. The class of biosolids is either AA, A and/or B. Class AA Biosolids is the highest level of quality and safety that can be produced. The applications of the biosolids are denoted by an "X" in its respective column.

County/Region	Class (A or B)	Farmland & Agriculture?	Private Landscaping/Use?	Forestry?	City Landscaping?	Reclaimed Water for Irrigation?
Centralia (WA)	A	X	X			X
City of Everett (WA)	A and B	X	X	X	X	
King County (WA)	A and B	X	X	X		X
Spokane County (WA)	A and B	X				X
Orange County (CA)	A and B	X				
Solano County (CA)	B	X	X			
Lee County (FL)	AA*, A and B	X	X			
Lancaster Area Sewer Authority (PA)	A	X	X			

*Class AA Biosolids is the highest level of quality and safety that can be produced. Lee County sells and markets this class as their own OrganicLee Compost, sold to their residents.

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Figure 2: Classifications of biosolids produced in each case study.

County	Sources
Centralia (WA)	http://www.cityofcentralia.com/Files/2015_PW_Annual_Production_Report.pdf
City of Everett (WA)	https://everettwa.gov/589/Biosolids
King County (WA)	http://www.kingcounty.gov/~/media/services/environment/wastewater/resource-recovery/docs/biosolids/Biosolids_Plan.ashx?la=en
Spokane County (WA)	https://my.spokanecity.org/publicworks/wastewater/treatment-plant/ https://www.spokanecounty.org/1117/Biosolids-Management
Orange County (CA)	http://www.orangecountyfl.net/Portals/0/Library/Water-Garbage-Recycle/docs/BiosolidsBrochure.pdf http://www.swanafl.org/Resources/Events/2015%20Winter%20Conference/Presentations/Howard.pdf
Solano County (CA)	https://admin.solanocounty.com:4433/civicax/filebank/blobdload.aspx?blobid=20801
Lee County (FL)	http://www.hazenandsawyer.com/work/projects/lee-county-utilities/ https://swana.org/portals/0/awards/2014/Composting/Lee%20County%20CompostingSystems.pdf
Lancaster Area Sewer Authority (PA)	https://www.lasa.org/images/pdf/Biosolids_Project_FAQs.pdf

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Figure 3: County websites for referencing more information.

Bulking Materials for Biosolids Composting

Andrea Dye, Chuan Di, Michelle La, Eric Parsons

Background information - Bulking Material

The City of Albany is exploring different options of bulking material to compost biosolids. Bulking materials are an ingredient used to improve structure and to lower moisture content. They also improve convective air flow and reduce settling and compaction. Bulking materials may include, but are not limited to, wood waste, straw, and other high-carbon materials. Biosolids are a byproduct of the wastewater treatment process. When mixed with appropriate volume and type of bulking materials and treated through the composting process, biosolids become a nutrient-rich compost product that can be applied in a variety of ways. The ideal volume and type of bulking material depends on multiple factors: geographic region, moisture level in the air, supply volume and consistency, choice of processing operation, and desired product.

When choosing the most financially, environmentally, and socially feasible bulking material to process biosolids, the composting operation selected will determine the material type that will produce the best outcome. Each type of operation requires different balances of inputs, airflow quantity, and processing lengths.

There are several processing options to be considered when selecting bulking material:

- Aerated windows commercial composting (static): Long narrow piles of organic wastes that include different proportions of feedstock, the materials used other than biosolids. The pile of organic material (in this case biosolids) is combined with loosely packed bulking materials to induce airflow. Some aerated windrows are placed on top of a network of pipes that will provide the airflow that is needed to process the organics (US Environmental Protection Agency, 2016).
- In-vessel commercial composting: Organic waste is put into a silo, drum, trench, or other enclosed environment for processing. This type of operation is less space consuming and the processing environment can easily be controlled. Bulking material is added to the organic waste in an in-vessel system (US Environmental Protection Agency, 2016).
- Anaerobic Biodigestion: A tight sealed process where microorganisms will break down waste materials to produce biogas and methane as a final product. This process requires a very small amount of bulking materials (Office of Energy Efficiency & Renewable Energy, 2013).

In addition to the level of processing, temperature, moisture, carbon, and nitrogen, the density of materials and their physical properties need to be accounted for to create the perfect recipe of biosolids and bulking material. Different materials have different optimum levels of nitrogen and carbon levels to account for in the selection process. Because nitrogen and other nutrients are lost in the composting process, the bulking material is vital to filling this gap. Moisture levels of biosolids can range from 5%-99% (HDR, 2012). Material with higher moisture content will require a drier bulking material. The physical properties of the bulking material affect how well the biosolids will break down and the length of processing that is needed to completely transform the biosolids and bulking material into nutrient filled compost.

The Carbon to Nitrogen (C:N) ratio depends on the bulking materials used in aerated or in-vessel composting operation (Figure 1).

Material	*% N (dry weight)*	*C:N*
Corn stalks	0.6-0.8	60-73
Straw	0.3-1.1 (0.7)	48-150 (80)
Bark, hard woods	0.1-0.4 (0.24)	116-436 (223)
Bark, soft woods	0.04-0.39 (0.14)	131-1285 (496)
Newsprint	0.06-0.14	398-852
Sawdust	0.06-0.8	200-750
Wood chips	0.04-0.23 (0.09)	212-1313 (641)
Leaves	0.5-0.13 (0.9)	40-80 (54)

The numbers in parentheses are averages.

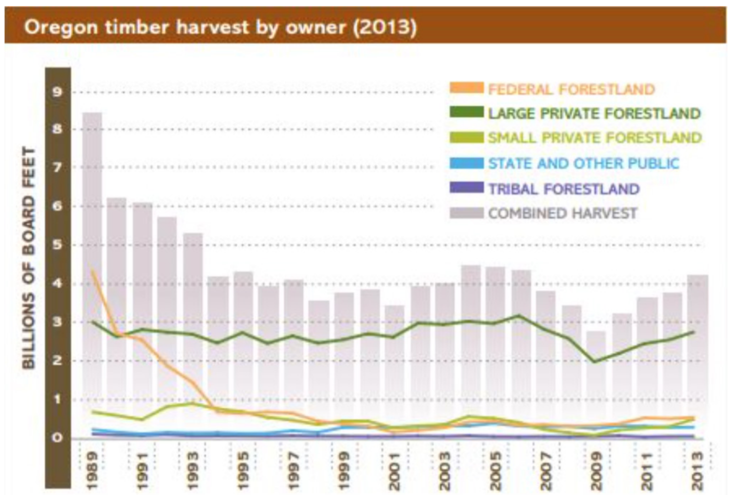
Source: Wortmann & Shapiro, 2012

Figure 1: Carbon content and C:N ratio of bulking materials

The City of Albany recently conducted a feasibility study of an on-site aerated composting pile using wood waste as a bulking material. The results of that study can be used to determine whether wood waste would work in the intended operations. Depending on the results, an additional bulking material may need to be added to the recipe.

Traditional Bulking - Wood Waste

Traditional bulking material for composting comes from plant waste, primarily in the form of wood waste from lumber production or agriculture waste. Approximately 80% of Oregon's 30 million acres of forests are classified as timberland, meaning that they can produce commercial grade timber (Oregon Forest Resources Institute, 2016). Since the mid 1990's, Oregon's timber harvest has remained relatively constant with approximately 3.5-4 billion board feet harvested per year (Figure 2). The consistency of this harvest is an important factor when considering new operations, which are dependent on a consistent supply of wood waste. Oregon boasts over 50 lumber mills with at least five in the Albany area.



Oregon Forest Resources Institute, 2016

Figure 2: Breakdown of Oregon timber harvest by owner

<u>Paper mills</u>

Paper mills in Oregon are well suited to take advantage of the strong timber and lumber industries. Paper mills use pulp and bark waste from lumber mills as the primary input for paper production. The production of paper in Oregon has been volatile in recent years, ranging from $824 million - $1.1 billion in gross domestic product (Knoder, 2015). In Oregon and across the U.S., paper demand is falling. Demand for advertising paper and magazine paper has fallen by 21% in the last decade (denverpost.com). With the prevalence of online and electronic reading devices this demand is projected to decrease another 18% by 2024 (The Minneapolis Star Tribune, 2016). This decline will increase the availability of wood waste from lumber mills and potentially decrease the price. Although paper demand is decreasing domestically, paper use is increasing globally by approximately 3% per year. Most of the increasing demand is occurring in Asia and with recent international trade uncertainty, Oregon mills may be unable to capitalize on the global market. Overall, paper mills are the strongest competitor for acquisition of wood waste, but this pressure may abate.

Engineered Wood Products

Engineered wood products currently do not constitute a significant portion of the wood waste available in Oregon. The largest competition comes from the production of plywood, particleboard, and wood pellets. These products are in prevalent use and constitute a large portion of the sawdust and wood chips procured from lumber mills.

Particle board demand has grown with the recovery of the housing market and increased use in furniture, constituting up to 90% of furniture in some cases (FDMC, 2014). Cross-laminated timber is a new wood product, which may be able to take the place of steel and concrete in buildings. Currently under development with D.R. Johnson and Oregon State University, cross-laminated timber may present a significant threat to the availability of wood chips. For this threat to be realized, the product must first be approved by building code revisions.

Cogeneration Plants

Many mills in Oregon ship excess wood chips overseas to Japan and China for use in cogeneration plants. In Riddle, Oregon, D.R. Johnson Lumber trucks wood chips to Coos Bay where Japan and China purchases the chips at $40 per dry ton. This waste is considered a low value product and results in little to no profit.

Purchasing Bulking Materials from Lumber Mills

Large mills in Oregon operate seven days a week and produce consistently. Production may increase in the spring and summer and then decrease for winter, but this change is a small portion of total capacity. Medium and smaller mills have lower volatility in production and generally run 40 hours per week. For example, D.R. Johnson Lumber is a small-medium sized mill operating Monday through Friday, producing around 180,000 board feet of lumber per day.

To purchase waste from lumber mills, demand must be constant. Mills appear to be unwilling to sit on waste material, like wood chips and sawdust, so the purchases must be regular and in large enough quantities to ensure buildup of waste does not occur. This may not be an issue if a partnership with a lumber mill of appropriate size accommodates the needs of Albany. Additionally, contracts for waste purchases are often made on a quarterly basis so finding an opportunity to enter in the supply chain should not be challenging.

Bulking Alternatives

The City of Albany's primarily choice to investigate wood wast as the bulking material for biosolids composting. The U.S. Composting Council includes the following as viable alternatives to wood waste suitable bulking materials:

- Yard trimmings, including grass clippings, leaves, weeds, stumps, twigs, tree pruning, Christmas trees, and other vegetative matter from land clearing activities.
- Food by-products, including damaged fruits and vegetables, coffee grounds, peanut hulls, egg shells, and fish residues.
- Industrial by-products from wood processing, forestry, brewery and pharmaceutical operations, paper goods, paper mill residues, and biodegradable packaging materials.
- Municipal solid waste following mechanical separation process to remove non-biodegradable items such as glass, plastics, and certain paper goods (US Environmental Protection Agency, 2002).

The availability of sufficient amounts of these bulking materials will be a significant issue for the city. In addition, the carbon and nitrogen content of the wastewater solids must be balanced against the bulking material content to achieve a suitable carbon to nitrogen ratio. The recommended ratio is between 25 and 35 parts carbon to one part nitrogen (US Environmental Protection Agency, 2002). Although the agents listed above are viable in composting, not all will be suitable for composting biosolids.

Yard/Green Waste

As yard waste collection service is offered by Republic Services in Albany, a ready stream of material may be available from Albany residents, but in unknown quantities. High seasonal variations in quantity and type of material would also need to be addressed. For example, an abundance of grass clippings in the spring and summer could result in elevated nitrogen levels, causing the compost to become anaerobic and malodorous (Cornell Waste Management Institute, 2004).

With nearly 68,000 acres dedicated to growing Christmas trees and 6.5 million trees harvested annually, industry discards may be a viable source of bulking material. However, seasonality of material supply would again be a concern. In addition, although the industry output is large, approximately 92% of harvested trees are exported out of the region (Oregon Forest Resource Institute, 2016).

Dairy Waste

With approximately 126,000 dairy cows on 228 multi-generational dairy farms in Oregon, used bedding from dairy farms may be a viable bulking material (Oregon Department of Agriculture, 2016). Bedding choice depends on the type of housing used, but most commonly consists of sawdust, wood shavings, or straw. Lime is commonly added to reduce pathogen growth. With a carbon to nitrogen ratio of between 40 and 100 parts carbon to one part nitrogen for straw, and between 100 and 500 parts carbon to one part nitrogen for wood shavings and sawdust, both materials contain high enough carbon levels to be useful in balancing the high nitrogen levels in biosolids (UMass Center for Agriculture, Food and the Environment, n.d.). Bedding is replaced every four to five days, ensuring a regularly available supply of material for the city. As dairy farms operate 365 days per year, there would be no seasonality to consider. There are ten farms within Linn County alone, but total bedding output from these farms is unknown.

Paper Waste

Partnership with a paper mill could present Albany with a consistent source of waste that would otherwise be incinerated or placed into a landfill. Albany is located close to several paper mills including International Paper, which is a large producer of paper. Not all waste classes from a paper mill may be suitable for composting however.

Primary sludge contains mostly fillers and fines, which would be good sources of carbon for composting. Primary sludge can often be reincorporated into the paper process. If the product is high-end, then primary sludge will often be dewatered and incinerated or placed into a landfill.

Secondary sludge poses handling difficulties as it often contains large amount of microbial proteins that could be composted, but does not meet the carbon needs of the City of Albany.

The amount of waste and quality of waste for composting purposes depends on the amount of recycled paper and technology used at the mill. The more recycled paper used in the milling the process, the higher the deinking sludge content (waste that introduces heavy metals and toxic substances into a composting operation) and would decrease the amount of primary sludge. Kraft mills primarily use raw inputs in the production process and produce the most viable waste.

The amount of waste occurring during paper production differs by type. This is data from European mills and is between six to ten years old so current production practices might differ (Figure 3 and Figure 4).

Waste	Yield (kg/t o.d. pulp)
Wood wastes:	
Sawdust coming from the slasher deck	10–30
Bark falling from the debarking drum	100–300
Pins and fines from chip screening	50–100
Wood waste from woodyard	0–20
Knots from pulp deknotting	25–70
Sodium salts from recovery boiler	5–15
Dregs and grit from causticizing:	5–10
Dregs	10–30
Grit	15–40
Total:	220–615

Bajpai, 2015

Figure 3: Breakdowns for type and amount of waste in a Kraft mill

	SCA	Norske Skog	Stora Enso	Holmen
Mill production (millions of tonnes)	9,9	4,8	15,1	2,3
Total waste generated (kg/ton product)	163	163	155 (dry)	160
Recovered waste (kg/ton product)	115	138	–	136
Waste sent to landfill (kg/ton product)	47	16	22	23 (wet)
Hazardous waste (kg/ton product)	0,3	1,5	0,3	0,2

Based on Monte et al. (2009)

Bajpai, 2015

Figure 4: Amounts of waste for several European mills

Financial Considerations

Transportation

Because bulking materials are not generated at the same facility as the biosolids, transportation and hauling costs are critical in the evaluation process. The weight and physical properties of the chosen bulking material impact cost. Cost is also impacted by the distance materials will have to be transported. If the bulking material and farther away, associated costs will be higher.

Operations

Capital costs will vary as well depending on the infrastructure needed. The pilot study completed by the City of Albany included a small scale pilot composting project on-site. A large scale project will require more capital, and potentially land space, which will have other implications such as land use and permitting requirements.

Consistency in supply

The availability of certain types of bulking material may cause fluctuations in procurement prices. For example, seasonal materials for Christmas trees may be priced differently throughout the year than other products. Supply and demand of certain bulking materials will be priced per ton, pound, square foot, or square meter.

In the case that additional processing of the procured bulking material is needed, there will be added costs. In rare cases, commercial composters have an extra processing step that will ready the bulking material to be used as a feedstock for composting. A simple example of this is the chipping of wood materials into a smaller physical form that can be used in conjunction with biosolids containing specific moisture levels.

Conclusion

Based on our research, a small number of possible bulking materials are viable in composting operations involving biosolids. Biosolids by nature are likely to have a high moisture content, which deem food waste and most dairy waste (manure or feed) to not be feasible. Our recommendation is to pursue wood waste as a bulking material, particularly because of our interview with a lumber mill in Oregon. The supply of wood chips and potentially wood dust, which is a good drying material, is available as long as the demand for the material is consistent. Evaluation of a possible composting operation on site or partnering with a commercial composter will hinge on several factors to determine the best route to pursue. From there, the City of Albany can select the bulking material that is financially, environmentally, and logistically viable.

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Public Private Partnerships for Biosolids Management

Bret Merchant, Anna Raithel, Eddie Rosenberg, Collin Strong

This report provides the City of Albany with a 360-degree analysis of private partnership opportunities to add value to the city's current wastewater treatment strategy. Our research analyzed potential (1) outputs for Albany's wastewater management and conversion (e.g. biosolids) programs, (2) constraints of potential wastewater treatment initiatives, and (3) advantages attainable through partnerships with the private sector to minimize these constraints. This report uses secondary research that examines the biosolids industry and supplements it with primary research gathered from interviews conducted with private businesses specializing in wastewater management and biosolids, such as Rexius and Synagro. Pooling the collective efforts, resources, and strengths of both the public and private sector is an effective strategy. It allows otherwise unobtainable objectives to be accomplished. Research found many opportunities exist to increase the value and effectiveness of Albany's wastewater management program. This report is best utilized by cross-referencing the findings with internal city knowledge and resources, and then developing a strategy to improve the wastewater management processes.

Introduction of Potential Outputs

There are four primary biosolids products proven useful in communities across the Pacific Northwest. These include Class B Dewatered Biosolids, Class A Lime-stabilized Biosolids, Class A Compost, and Class A Thermally Dried Pellets. The following provides an overview their advantages, disadvantages, and attractiveness to key private-sector partnerships.

Class B Dewatered Biosolids are useful in several key Pacific Northwest markets and industries such as agriculture, forestry, and reclamation. Yet, its crude form and potential health hazards limit most applications. Class A Lime-stabilized Biosolids provide several advantages over Class B Dewatered Biosolids. They are useful in the same geographical region and industries, but can be applied in other settings like city parks and streets. However, Class B Dewatered Biosolids and Class A Lime-stabilized Biosolids, both have significant drawbacks when used within city limits. They are prone to odor and lack desirable aesthetic qualities.

Class A Composted Biosolids, used in projects supporting parks, forestry, horticulture and streets, are excellent for general public use, such as landscaping and gardening. Yet, resident education and advertising campaigns are necessary to overcome biosolid's stigma. Composted biosolids provide more opportunities to develop partnerships with the private sector. For instance, local landscaping companies may find value in composted biosolids as a substitute product for commercial and residential landscaping applications. Local composters and fertilizer brokers may find value incorporating these composted biosolids into their custom and standard blends for various agricultural applications.

Class A Thermally Dried Pellets are the most attractive product to develop private-public partnerships because it is a high quality fertilizer for agriculture, golf courses, and turf applications, such as athletic fields and grassy areas in parks. These pellets can also be used to fuel industrial applications such as cement kilns. Additionally, thermally dried pellets are excellent fertilizers for personal lawns and gardens. Yet, similar to composted biosolids, implementing an educational advertising campaign for local residents is likely necessary to overcome stigma stemming from the origin of the compost. Class A Thermally Dried Pellets ability to fit many applications provides the most attractive product for the private sector. However, pricing and application fit is vital to developing a long-term strategic partner.

Jack Hoeck, Vice President of Environmental Science at Rexius, in Eugene, Oregon, responded to interview questions about biosolids. Rexius recycles and processes organic waste for landscape, agricultural, and environmental industries, while providing services for irrigation, environmental restoration, and erosion control. He explained biosolids retain more water than synthetic fertilizer. This is important in agriculture, which demands huge amounts of water, most of which ends up as runoff. Less runoff also means less risk of other agricultural products getting into local water supplies. Water retention is becoming increasing vital in drought-stricken but food production heavy places like California and the Midwest. Biosolids could also impact environmental reclamation and/or rehabilitation. Those areas are often restricted to public use for long periods of time, so Class B could be used to add nutrients back into the soil, encourage plant growth, and retain water.[1]

1 Jack Hoeck (Rexius: Eugene, Oregon) in conversation with Bret Merchant, Anna Raithel, and Collin Strong, November 2016.

It is important to note, synthetic fertilizers are cheap, plentiful, and subsidized. Biosolids are more labor and cost-intensive. The market for synthetic fertilizer are more volatile. If the price of oil drops and synthetic fertilizers become cheaper than organic fertilizers, any contracts made with biosolids producers would become financial burdens. Sewage is a relatively stable input, unaffected by seasonality. However, the growing season is primarily in the spring/summer, so storage of biosolids may be necessary.

Albany's Current Practice

Before researching other frameworks, it will be helpful to identify how the Albany-Millersburg Water Reclamation Facility (A-M WRF) in Albany is currently disposing of their waste. This will establish a baseline for comparison. When interviewed, A-M WRF Supervisor Scott LaRoque confirmed their plant diverts 100% of its sludge to the Coffin Butte landfill.[2] This practice is caused by the inability to digest their sludge. However, LaRoque also described an potential evaluation of the viability of producing marketable Class A or B Biosolids.[3] Albany, however, sends both to the landfill as a result of regulations involving secondary use of Class A and B Biosolids.

The monthly invoice from Republic Services confirms a tipping fee (amount paid per full dumpster) fee of $199.59, along with $36 per wet ton fee, and an additional 'Economic Recovery' fee of $25 per ton.[4] It is important to highlight that these fees are merely for the disposal of the sludge and that additional fees, such as the costs for transportation, add to this total. Unfortunately, this practice is not uncommon among municipalities and LaRoque offers that "realistically...we're just trying to get rid of the sludge for free."[5] Having an understanding of the costs involved with current disposal practice will factor into negotiations with the private party and help shape the financial details of the partnership. Charlotte County illustrates a public-private partnership, which highlights the added advantage of requiring no additional exertion on behalf of the municipality.

2 Scott LaRoque (Albany Reclamation Facility), in discussion with Bret Merchant, November 2016.

3 Ibid

4 Ibid

5 Ibid

Elements for Consideration

LaRoque's comments suggest, Albany could entertain competitive offers that cost the same or less than Albany currently incurs, and with the added benefit of increasing health and public benefits. The city appears to prefer both minimal and cost-effective involvement, but also is comfortable with further treatment of biosolids and the accompanying marketing efforts. Albany should consider the following elements, which will help to shape the preferred framework of a public-private partnership.

Scale and Proximity

In consideration of the infrastructure needed to produce marketable biosolids, Albany must gauge the optimal amount of inputs and outputs. With approximately 55,000 residents in the City of Albany alone,[6] the city should take into account what options are available and recommended for serving as many residents as possible. Robert Pepperman, a Project Developer for Synagro, advises "that size of city doesn't necessarily warrant significant capital investment in terms of building further processing facilities, situating a facility that could aggregate capacity from surrounding treatment plants might be a viable option."[7] There are dozens of wastewater treatment facilities (WWTF's) spread throughout Oregon.[8] Due to Albany's population, it may be more efficient to aggregate outputs from neighboring facilities into a central location. Albany could collect inputs at their existing plant or at another location close to the Coffin Butte landfill where other WWTF's are currently disposing their sludge. Through strategic placement of the private facility, one operation may be able to serve many surrounding WWTF's and act as a centralized aggregator of sludge. This is especially important for smaller treatment facilities already struggling from both increases in regulation and constricting budgets, like in North Bend, Cottage Grove, and Metolius.[9] If a favorable site can be selected for a private partner to receive sludge from surrounding municipalities, this will help to achieve scale, help streamline the efforts of those municipal treatment facilities, and divert substantial waste from landfills.

6 "Population Demographics for Albany, Oregon in 2016 and 2015" Suburban Stats, accessed November 2016. https://suburbanstats.org/population/oregon/how-many-people-live-in-albany.

7 Robert Pepperman, in discussion with Bret Merchant, November 2016.

8 Oregon's 52 Largest Wastewater Treatment Facilities: SB 737 Requirements. PDF.

9 Wastewater Treatment essential, but costly for smaller cities. Oregon Department of Energy, PDF.

Regulation

Disposal of wastewater and application of biosolids is an intensely regulated sector. As a result of the changing regulatory landscape, Albany should consider if it would be more efficient to "pass-through" responsibilities to a certified private entity. Fortunately, Synagro, one of the leading businesses in wastewater management and specializes in such regulatory frameworks and offers "single party responsibility," which allows for risk transference from municipality directly to Synagro.[10] As a result of Synagro's experience, they are accustomed to wastewater and biosolid treatment regulations and can inherit the accompanying regulatory risk and liability at any stage along the receiving, treatment, distribution, and application process.

Expertise

As a public entity, the chances for Albany to make meaningful penetration into the marketing, sale, and distribution of biosolids may be limited. As a non-profit, municipalities are not accustomed to seeking out revenue generating streams for their products and services. Operating under strict budgets can often lead to efforts resulting in favor of the most economical, or cost-effective means of wastewater disposal. This often comes in the form of diverting waste to landfills through an inefficient process. It is recommended that responsibilities be turned over to a private party. Through the business acumen of companies like Synagro, treatment, preparation, distribution, business-to-business and business-to-consumer contracts of biosolids become routine, prioritized, and strategically planned. Indeed, such practices may parallel those coveted by the municipality, but may be less likely to materialize from the municipalities inexperience.

A lack of qualified personnel may also constrain some municipalities. When asked about the staffing or job creation impact of a typical Synagro project, Pepperman responded that they usually bring in a management team to operate and then hire other qualified personnel from the community to fill open positions. Another option listed was bringing in a plant manager to oversee all operations, and then fill openings with qualified members of the surrounding community. Pepperman emphasises that preserving the "partnership" aspect of the relationship is a core value for Synagro and building a strong community workforce it a crucial component to this solidarity.[11]

10 "Facility Operations," Synagro, accessed November 2016. http://www.synagro.com/offerings/facility-operations/.

11 Putnam, 2016.

Capital and Resources

Albany is not pressured to produce a financially profitable operation. There exists little economic justification to invest significant capital into their biosolids facility. In addition to capital constraints, the additional resources needed to process, transport, and manage biosolids are substantial. Such resource requirements may include:

- Capital needed for purchase of land
- Specialized machinery for processing and preparing biosolids
- Truck fleet for transporting of sludge or biosolids
- Shelter for protection and preservation of finished product
- Labor needed to produce marketable biosolids
- Permitting fees

Early private involvement in the treatment process can save municipalities from such capital expenditures, allowing them to focus on maintenance of their existing and vital resources, while freeing the city to prioritize other projects.

Although private entities may have more readily available capital, a thorough understanding of the financing terms must be prepared. Private entities will require a market-based return at the minimum. However, we will illustrate an exception later in the report where, if Albany is not limited by time constraints, it might be more beneficial for them to target various categorical grant programs offering advantageous financing terms. Regardless of when Albany relinquishes or keeps control of the treatment process, Synagro offers a variety of models integrating with current operations or establishing new frameworks.

Contracts

Municipalities may have concerns about entering into a long-term contract with a private party. LaRoque confirms that entering into a 15 year contract could present a significant roadblock.[12] However, Synagro offers a number of attractive and flexible tools to alleviate such concerns. While a traditional contract might last 20 years, contracts of five, ten, and 15 years are available depending on the partnership structure. If a design-build-operate (DBO) model is deemed appropriate, the contract might start at a minimum of 15 years, so that both parties have a chance to recoup their investment and allow for a longer amortization of the loan repayment. Other DBO arrangements can also

12 LaRoque, 2016.

start with a smaller contract term and be updated with extension clauses in the event both parties wish to continue the current partnership.

In addition to the strict length of the contract, municipalities may also be cautious of the fee structure involved with the partnership itself. Again, Synagro offers a variety of terms. Using the Charlotte County partnership as an example, Pepperman reinforced that Charlotte County could have continued to pay the tipping fees and associated costs, which bring with it the possibility of increasing, sometimes substantially, every year. In contrast, Synagro offered a fixed, below market rate for processing of the county's waste for the first five years, followed by a CPI adjusted rate in years six through ten, and finished the contract with an adjustment for both CPI and inflation. Pepperman was clear that although a for-profit entity, Synagro seeks to meet the demands of the existing operations that are in place, and searches objectively for the best feasible solution that meets the interests of all parties involved.[13] He acknowledged that the contract in Charlotte County was unfavorable for Synagro, in terms of the fee structure, but that their excellence in the DBO execution made the project financially viable.

13 Pepperman, 2016.

Services

An overview of the services provided by Synergo is necessary to illustrate the flexibility, scope, and resources provided by the private sector. Such services can help Albany officials alleviate potential restraints or concerns.

Transportation

The lowest level of partnership available with the private entity consists of providing disposal or transportation services. If Albany maintains initial treatment of the wastewater, the disposal of any residuals may be carried out by the private party via tanker, roll-off, pumper trucks, or dump trailer. Additionally, Synagro's rail terminals and transportation services provide logistics and intermodal transport across the country. Additional benefits to rail transport comprise of convenience to the municipality, and reduce the carbon footprint, fossil fuel use, and traffic congestion associated with truck transportation.[14] With truck and rail disposal options, it allows Albany to minimize its added effort to form a partnership while providing peace-of-mind as the private entity takes on the risks and liability accompaning the movement of such hazardous waste. Arranging for private pickup gives Albany flexibility in deciding the class of biosolid to produce as the private party is able to accept a variety of products and then use their own discretion to dictate its aftermarket use.

Alkaline Stabilization

As a result of Oregon's agriculture and mining industry, adding alkaline to waste residual sources poses as an attractive option. Advantages of Alkaline Stabilization include flexibility in producing either Class A or B products, as well as minimal infrastructure setup and maintenance. Synagro's BIO*FIX system uses pH and temperature are used consistent with environmental and public health standards established by federal, state, and local regulations. The process controls odors, inactivates pathogenic microorganisms, prevents vector attraction, minimizes capital and operation costs, and minimizes use of process water and energy, while requiring a small footprint for the processing facility.[15] The processing facility can be built near or in addition to the WWTF, or the residuals can be transported back to a centralized "receiving" facility. The Class B product provides an attractive option for agricultural land application or mine reclamation, while the Class A can be used as a lime substitute, soil amendment, or landfill cover.

14 "Greater New Haven Water Pollution Control Authority," Synagro, accessed November 2016. http://www.synagro.com/locations/greater-new-haven-water-pollution-control-authority/.

15 "Alkaline Stbilization" Synagro, accessed November 2016. http://www.synagro.com/offerings/alkaline-stabilization/.

Composting

Composting is a cost-effective option for producing Class A Biosolids, and as a product for agriculture, horticulture, and landscaping. Albany's involvement could be limited as Synagro could offer their expertise in siting, constructing, and operating a broad range of facilities. Further support from the private entity may take the form of private capital, assured product marketing, and comprehensive regulatory compliance services.[16] Synagro offers clients its existing composting facilities or they can work with the municipality to develop a unique plan.

Land Application

For strictly Class B output, redirecting biosolids into clean, safe, and productive materials for land application is worthwhile for both operations and the environment. It can also prolong the useful life of surrounding landfills. With industry penetration and marketing expertise, private coordination of viable land application and reclamation clients could alleviate any of Albany's additional efforts. They could haul, manage, permit, and monitor regulations. Synagro can collaborate with regulatory agencies, universities, and policymakers to influence the field and offer a national perspective on regulatory trends.[17]

16 "Composting" Synagro, accessed November 2016. http://www.synagro.com/offerings/composting/.

17 "Land Application" Synagro, accessed November 2016. http://www.synagro.com/land-application/.

Product Marketing

It should be reinforced that a public-private partnership may include several parties, particularly on the private side. Partnerships may involve a municipality connected to the end consumer of the residuals or biosolids via a third-party serving as marketer to expose the product's attractiveness. Such a partner may be contracted to secure customers with long-term contracts or one-off projects. If Albany is to invest the capital necessary to create marketable biosolids, they should develop and secure a reliable product management strategy. This role may be assumed most effectively by a private entity. Responsibilities for the private party may include: Product marketing, ensuring product is used quickly and effectively, attending to regulatory controls, testing, labeling, certifying, insulating the treatment facility from claims and concerns about product misuse, and billing and collections services.[18]

Existing Public-Private Partnerships

Synagro, a Maryland based company that specializes in biosolid and residual solutions services, has dominated this industry in the US since 1986.[19] They are the largest processor of sludge and biosolids in the country and some of their expertise includes: Recycling, cleaning, repair and maintenance, transportation and disposal management, facility management, permitting and regulatory compliance, and design-build-operate (DBO) models. With several public-private contracts already in place, they offer several permutations of the basic DBO model. Additional components of the a public-private partnership may include financing, ownership, and maintenance. The circumstances unique to each wastewater environment will be taken into account when deciding what permutation is most appropriate. Albany should consider each circumstance as provided by either themselves, a private party, or a public-private partnership. Several existing public-private partnerships with various attributes relatable to Albany are highlighted in the following section.

18 "Product Marketing" Synagro, accessed November 2016. http://www.synagro.com/product-marketing/.

19 "About Us" Synagro, accessed November 2016. http://www.synagro.com/about-us/.

Honolulu Sand Island Wastewater Treatment Plant

The City and County of Honolulu (CCH) entered into a design-build-operate (DBO) partnership with Synagro in 2002, resulting in a bioconversion facility. This particular facility provides digestion, dewatering, and heat drying and pelletization of biosolids for Hawaii's largest wastewater treatment plant. Synagro confirms that the goals set for this facility include compliance with EPA regulations, minimizing the need to place biosolids in landfills, and implementing a Class A Biosolid recycling program meeting the standards for exceptional quality.[20] As part of the ongoing relationship, Synagro staff members meet regularly with CCH officials and local businesses to participate in efforts to preserve the environment and enhance sustainability efforts.

Synagro's involvement in the DBO was a critical component because the neighboring landfill was expected to reach its permitted capacity in 2003. This showcases the value of including an experienced and reputable partner as a component to meeting the unexpected demands WWTFs sometimes encounter. The DBO model, as opposed to design-build-operate-own (DBOO), was chosen because CCH wanted to maintain control of the facility.

Whereas we mentioned previously that private capital may be more readily available for building infrastructure, there exists a unique and low-cost source of capital with which municipalities should look to acquire. Known as the Clean Water State Revolving Fund (CWSRF), this federal-state partnership provides communities a permanent, independent source of low-cost financing for water and sanitation infrastructure projects.[21] Pepperman confirmed the importance of capitalizing on this type of funding and why the DBO model fits with this structure. "If Synagro were to finance the operation, the funds would come out of operating capital, which would require a six to seven percent return... if the city can secure funding through programs like CWSRF, they may be able to secure capital at two, or even zero percent interest and treat the loan as a low-cost mortgage payment over the life of the contract."[22] What's more, with financing at such low rates, this allows municipalities to afford a facility with 100 tons of capacity for example, even though they currently need only 40 tons, which adds to the plant's flexibility and resiliency," Pepperman offered. In this framework, where the municipality wants to retain ownership, they benefit from affordable financing while also capitalizing on expertise and facility management offered by the private party.

20 "Honolulu Sand Island Wastewater Treatment Plant" Synagro, accessed November 2016. http://www.synagro.com/honolulu-sand-island-wastewater-treatment-plant/.

21 "Clean Water State Revolving Fund (CWSRF)" EPA, accessed November 2016. https://www.epa.gov/cwsrf.

22 Pepperman, 2016.

Although CCH contributed to the DBO process, they were able to maintain their core competencies while allowing Synagro to explore the most economical, environmental, and socially acceptable means of processing while also assuming operational responsibilities after completion of the facility.

The benefits of the CCH facility and partnership with Synagro include decreasing landfill disposal of biosolids from 100% to only 7%, minimizing the need to expand Oahu's landfill. This also led to conversion of CCH's biosolids into an attractive Class A Fertilizer for agriculture, commercial, and generation of biogas alleviating the island's dependence on imported fossil fuels.[23] Albany may benefit from similar landfill diversion results as they too will inevitably face similar circumstances. Additionally, the Class A Biosolid distribution practices could also benefit Oregon's agriculture industry. However, as voiced by Hoeck, even the Class A Biosolids may encounter some pushback depending on the agriculture use and company's concerns for their reputation.[24] Lastly, as a result of the potential for affordable CWSRF financing, Albany may want to entertain a DBO model since they are already exploring the idea of expanding their facilities to produce marketable biosolids.

Greater New Haven Water Pollution Control Authority (GNHWPCA)

The City of New Haven and surrounding municipalities struggled to keep pace with their waste treatment as a result of failing thermal conversion equipment. This prompted reliance on a back-up alkaline stabilization system operated with outdated odor control technology. The GNHWPCA turned to Synagro for help resulting in both immediate and lasting benefits.

To meet the municipalities' immediate concerns, Synagro arranged for an interim solution by arranging for pickup and disposal of the plant's solids at a neighboring facility. This allowed time to find a multiple-hearth furnace, which the GNHWPCA commissioned Synagro to upgrade and refurbish into working condition for treatment of residuals and biosolids. Synagro then arranged for collection of sludge from nearby facilities, which resulted in capacity maximization, enhanced operational efficiency, and also provided an additional source of income for the host community.[25]

This sequence of events emphasizes the flexibility and creativity offered by forming a partnership with a private party. It is unclear whether Synagro continues to operate this particular facility, and it appears that this particular exchange of services was more reactionary in nature than a constructed, long-

23 "Honolulu Sand Island..." Synagro, November 2016.

24 Hoeck, 2016.

25 "Greater New Haven..." Synagro, November 2016.

term partnership. Nonetheless, these events demonstrate an additional channel of public-private collaboration. Furthermore, this interplay between parties illustrates why the rapid response of the private sector can be a complement to the public sector.

Waterbury Wastewater Treatment Facility

Threatened by regulatory requirements, biosolid generators in southern New England had trended towards landfilling and building expensive individual processing facilities. Looking for a more innovative solution, the City of Waterbury commissioned Synagro to renovate and expand an existing structure adjacent to their water pollution control plant. Under a 20-year agreement with the city, Synagro processes the sludge produced by the city and the facility has additional capacity to process sludge generated by as many as 35-40 other wastewater treatment plants in the surrounding region.[26]

In this model, Synagro not only encompasses the entirety of the treatment process, but also controls the marketing, delivery, and sale of the inventory. The Class A Biosolids are compliant with federal and state regulations and are used in the the region for fertilizer and as fuel in cement kilns as well as other biomass energy recovery systems.

Charlotte County Bio-Recycling Center

With limited landfill space and highly regulated application of Class B Biosolids, Florida municipalities needed a timely and innovative solution to managing the residuals produced by their WWTFs. Many of the plants did not include mechanical dewatering systems. Capable of providing mobile dewatering and cake transport, Synagro constructed the Charlotte County Bio-Recycling Center (CCBRC), which offers the ability to recycle both biosolids and yard waste.

In this relationship, Synagro receives the biosolids and residuals from the municipalities treatment facilities and turns 100% of the waste into Class AA Biosolids. The partnership is structured around a design-build-finance-operate-maintain (DBFOM) framework in which Synagro controls all processes after initial treatment.[27] Here, Synagro leased a site adjacent to the existing landfill, built, and now owns the compost facility, and now processes the wood-waste and biosolids. This relationship is unique in that Synagro processes the biosolids and recyclable material, slightly below the market rate. In Charlotte

26 "Waterbury Wastewater Treatment Facility" Synagro, November 2016. http://www.synagro.com/locations/waterbury-wastewater-treatment-facility/.

27 Pepperman, November 2016.

County, this practice results in about $100,000 savings for the municipality annually.[28] Furthermore, Charlotte County regulations require a special enzyme treatment, which is alleviated by the use of Synagro's facility and results in an annual savings of about $75,000 for the municipality. As a result of their ability to process wood waste, the facility also provides another $100,000 worth of savings to the country in wood waste processing arbitrage.[29]

In addition to cost savings, this partnership also generates revenues for Charlotte County and the site selection serves the interests of both parties. Supplementing the strict cost savings, the Charlotte County partnership also offers several revenue streams for the municipality. Synagro leases the land, paying the county an annual lease payment of $36,000.[30] Additional 'host fees' amount to about $40,000, which is paid directly to the county. In total, the partnership arrangement in Charlotte County results in a financial value proposition of over $350,000 split between cost-saving and revenue generation mechanisms.

The site selection process analyzed several key elements. By selecting a site to lease adjacent to the existing landfill, Synagro benefited from economies of scale. They not only serve Charlotte County, but are able to act as a central aggregator for surrounding WWTFs as a result of their proximity to the landfill. Furthermore, the site was also selected for its proximity to the landfill and multiple treatment plants. This positioning allows Synagro to support the surrounding municipalities' existing efforts without adding to their workload, while providing a public health benefit.

Another key attribute to the DBFMO public-private model is the speed with which the private party can execute their proposal. Pepperman highlights that once the permit is received from the state agency, the private party can easily meet building codes and begin processing biosolids. He attributes the response time of the Charlotte County recycling facility, which was completed three months ahead of schedule, to the availability of adjacent land, and Synagro's offering to the city council of a design that was nearly 100% complete. This allowed for minimal back-and-forth and allowed Synagro to begin construction quickly. In contrast, a typical Request for Proposals process usually involves considerable communication efforts between the county and any number of engineering firms.

28 Ibid.

29 Ibid.

30 Ibid

The CCBRC operation also provides regional municipal and industrial wastewater facilities, along with homeowners, landscapers, and local utilities who previously disposed of their yard waste in landfills, a superior solution that recycles their organic waste to create a valuable product.[31] With initial treatment assumed by the existing facilities, Synagro was sought out for their understanding of biosolids, ability to relieve Charlotte County of investing capital into specialized equipment and landfills, and excellence in marketing. When it comes to marketability, Pepperman asserts that Synagro has never had any contaminant issues and confirms Synagro works with other technology partners to determine the most practical approach. For expert assistance, Pepperman offers that Albany may wish to seek the counsel of Dr. Sally Brown at the University of Washington, who is an expert in soil amendments, in situ remediation, and carbon sequestration.[32]

Recommendation

The most critical component of wastewater treatment and deriving the appropriate technological solution is the end product.[33] It is important to clarify that Albany does not necessarily need to declare immediately whether they themselves want to take the production and marketing of the final product "in-house," which is a related but distinct decision on its own. Fortunately, there exist a variety of models available to meet the needs of municipalities, regardless of their current operations. As showcased, key elements regarding designing, building, operating, owning, financing, managing, and marketing of the facility should be considered. A public-private partnership, as evidenced by those currently practiced by Synagro, may consist of any combination of these factors. With the models previously illustrated, Albany can create a desirable framework with desirable elements to shape their facility, regulatory, and financial environment.

Based on the current state of the waste reclamation plant in Albany, the DBO model may be the most appropriate. With Albany producing sludge and transporting the waste to the Coffin Butte landfill, there is an opportunity to implement the DBO model with attributes of both the previously mentioned CCH and CCBRC operations. Similar to the CCH model, Albany can look to secure funding for construction of the new facility through the CWSRF program, which brings with it the elements of ownership and security. Although diverting waste from the landfill represents an element of urgency for Albany, they do not

31 "Charlotte County Bio Recycling Facility" Synagro, November 2016. http://www.synagro.com/locations/charlotte-couty-bio-recycling-center/.

32 Pepperman, 2016.

33 Ibid.

currently face severe time constraints. As a result, they do not necessarily need to rely on a private party to fund the development or renovation of required infrastructure. Consequently, this should allow for ample time to seek out and apply for categorical grant programs, such as the CWSRF, with favorable rate structures.

Like the CCBRC model, they can also allow a private party to explore an appropriate site close to the landfill so little effort from Albany is required. The private parties can make the new facility available to neighboring treatment plants and those with other recyclable waste. As a result of the wide variety of potential uses in Oregon for biosolids and compostables, allowing a private party to assume the commercial exposure and marketability of the inventory is also recommended. In addition to job creation, a private entity can also provide labor at reduced cost. Public agencies typically pay from 30% to 35% in fringe benefits for such benefits as health insurance, retirement, sick leave, and maternity leave whereas payroll overhead for private firms may be only 12% to 15%.[34] Furthermore, private firms are exempt from civil service requirements, providing them with greater flexibility in determining level of pay, fringe-benefit medical payments, and a mix of full- and part-time personnel.[35]

Allowing for a long-term contract of at least 15 years would also secure significant dividends with regards to extending the useful life of existing landfills for other, non-recyclable material. Additional benefits of a long-term contract include time for the financing party to reach an appropriate return on their investment as well as amortization of capital expenditures and other payments (i.e. lease, other debt service obligations). As an added measure of security, Albany can structure the lease agreement as a "possessory lease" so ownership of the land reverts back to city control after the lease term has ended. Similar to the CCBRC contract, Albany can add safety (i.e. indemnity) clauses and options to extend, or terminate, the partnership to preserve flexibility and mitigate unnecessary exposure. Lastly, Albany may want to entertain various leverage mechanisms, such as control over zoning, permitting processes, or tax abatements, as added incentives for private party buy-in.

34 Dennis R Howard, John L Crompton, "Financing Sport Third Edition," (FiT Publishing, 2013).

35 Ibid.

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